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NOTES ON THE LIGNEOUS PLANTS DESCRIBED BY LEVEILLE FROM EASTERN ASIA[1]

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ELAEOCARPACEAE

Sloanea sinensis (Hance) Hu in Jour. Arnold Arb. v. 230 (1924).

Castanopsis Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. XII. 506 (1913); Fl. Kouy-Tchéou, 125 (1914). — Camus, Châtaigniers, 375, 484 (1929). — **Synon. nov.**

Sloanea Hanceana Léveillé, Fl. Kouy-Tchéou, 420 (1915), vix Hemsley.

Sloanea chengfengensis Hu in Sinensia, III. 85. (1932). — **Synon. nov.**

CHINA. Kweichou: sud de Pin-fa, *J. Cavalerie,* no. 2514, Sept. 24, 1905 "arbre moyen, rare" (holotype of *Castanopsis Cavaleriei;* merotype in A. A.); Yang-kia-wan, Cheng-feng, in mixed woods, *Y. Tsiang,* no. 4641, Oct. 17, 1930 "tree 27 m., bark grey; fruit red" (holotype of *S. chengfengensis;* isotype in A. A.).

In his Flore du Kouy-Tchéou Léveillé enumerates Cavalerie's no. 2514 under *Castanopsis Cavaleriei* and also under *Sloanea Hanceana. Castanopsis Cavaleriei* had been already referred to *Sloanea* by Handel-Mazzetti (Symb. Sin. VII. 29, 1929) as *Sloanea* sp.; by A. Camus, l. c., it is enumerated as a doubtful species. *Sloanea Hanceana* Hemsl. = *S. Hemsleyana* (Ito) Rehd. & Wils. is very close to *S. sinensis* from which it differs chiefly in its larger leaves, serrate to near the base and in the shorter, slenderer and denser spines of the fruit.

I am unable to distinguish *Sloanea chenfengensis* from *S. sinensis.* Hu says it differs chiefly in the glabrous leaves and in the 4-celled fruits, but in *S. sinensis* the number of locules varies as in most species between 4 and 6 and the leaves are called by Hance in the original description "glaberrima" and so they are in all the specimens examined.

[1]Continued from p. 27; for preceding parts see Vol. x. 108-132, 184-196; XII. 275-281; XIII. 299-332; XIV. 223-252.

TILIACEAE

Tilia tuan Szyszylowicz in Hooker, Icon. Pl. XX. t. 1926 (1890).

Tilia tuan var. *Cavaleriei* V. Engler & Léveillé in Fedde, Rep. Spec. Nov. VI. 266 (1909). — V. Engler, Monog. Tilia, 124 (1909). — Schneider, Ill. Handb. Laubholzk. II. 389 (1909). — Léveillé, Fl. Kouy-Tchéou, 420 (1915).

CHINA. K w e i c h o u : Pin-fa, montagnes, au sud, *Cavalerie* no. 3227, May 30, 1907, "vu 7 ou 8 petits arbres, fl. blanc-jaune" (holotype of *T. tuan* var. *Cavaleriei;* photo. in A. A.).

Tilia tuan var. *Cavaleriei* represents the type of *T. tuan* according to Engler who has it as "var. α," and to Schneider. It differs only slightly from the type specimen in the somewhat narrower leaves, the upper ones measuring 9.5 by 4 cm. to 12 by 5.5 cm.

Tilia Miqueliana Maximowicz in Bull. Acad. Sci. St. Pétersb. XXVI. 434 (1880); in Mél. Biol. X. 687 (1880). — V. Engler, Monog. Tilia, 111 (1909).

Tilia Kinashii Léveillé & Vaniot in Bull. Sci. Bot. France, XLI. 422 (1904).

CENTRAL JAPAN: *Kinashi* no. 2, (holotype of *T. Kinashii*; photo. in A. A.).

Tilia Kinashii was already referred to *T. Miqueliana* by V. Engler and according to a note on the type specimen also by G. Koidzumi.

Grewia biloba G. Don, Gen. Syst. I. 549 (1831). — Handel-Mazzetti, Symb. VII. 612 (1933).

Grewia glabrescens Bentham, Fl. Hongk. 42 (1861). — Léveillé, Fl. Kouy-Tchéou, 419 (1915).

Grewia Esquirolii Léveillé, Fl. Kouy-Tchéou, 419 (1915), pro synon.

Celastrus euonymoides Léveillé, l. c. (1915), pro synon.

Grewia parviflora var. *glabrescens* Rehder & Wilson in Sargent, Pl. Wilson. II. 371 (1915).

CHINA. K w e i c h o u : Gou-réou, *J. Esquirol,* no. 3189, Dec. 1911 (probable type of *G. Esquirolii;* photo. in A. A.); Lo-fou rivière, *J. Cavalerie,* no. 3513, April 1909, "arb. 2 m." (type of *Celastrus euonymoides;* photo. in A. A.); same locality, *J. Esquirol,* no. 2204, Sept. 1910, and *J. Cavalerie,* no. 3492, Aug. 1909.

Grewia Esquirolii and *Celastrus euonymoides* are apparently manuscript names published only as synonyms of *G. glabrescens;* the name *C. euonymoides* appears on the label of Cavalerie's no. 3513, but on Esquirol's no. 3189 no name appears except *Euonymus* which is crossed out. Esquirol's no. 2204 is named *G. glabrescens* Benth. in Léveillé's handwriting, while Cavalerie, no. 3492, bears no name except "Grewia?", but was placed in the cover of *G. glabrescens.*

I am following Handel-Mazzetti in considering *Grewia glabrescens* identical with *G. biloba*. Don describes the leaves as smooth above, but pubescent beneath, which agrees with Bentham's description of the leaves as glabrous or sparingly sprinkled with a few short hairs on the upper side and dotted with a minute stellate pubescence underneath, while Bunge describes the leaves of his *G. parviflora* as "supra hispidulis, subtus stellato-canescentibus." The latter, therefore, becomes a variety of *G. biloba*. The two varieties, however, cannot be sharply separated and are closely connected by intermediate forms. There is also a difference in the shape; typical *G. biloba* has the leaves generally longer, oblong-oval to oblong-lanceolate, while those of var. *parviflora* are shorter and broader, ovate or oval, and usually smaller.

Grewia biloba var. **parviflora** (Bge.) Handel-Mazzetti, Symb. Sin. VII. 612 (1933).

Grewia biloba Burret in Notizbl. Bot. Gart. Mus. Berlin, IX. 708 (1926). — Rehder in Jour. Arnold Arb. VIII. 173 (1927).

Rubus umbellifer Léveillé in Fedde, Rep. Spec. Nov. VI. 111 (1908); in Bull. Acad. Intern. Géog. Bot. XIX. Mém. 16 (Ronces Chin. Jap.) (1909). — **Synon. nov.**

Grewia Chanetii Léveillé in Fedde, Rep. Spec. Nov. X. 147 (1911).

CHINA. Hopei: Kia-chan, *L. Chanet*, no. 571, Aug. 1910 (holotype of *G. Chanetii;* photo. in A. A.); mont de Pong-chan, *L. Chanet*, June 15-16, 1910 (in herb. Léveillé sub *G. Chanetii;* photo. in A. A.). Yunnan: près Pin-tchouan, *Jean Py* in herb. Ducloux, no. 618, April 27, 1906, "fleurs jaunes" (holotype of *Rubus umbellifer* in Herb. Univ. Calif.; photo. in A. A.).

The specimen from Yunnan approaches the type, but is rather densely pilose above and most of the leaves are oval or elliptic. *Grewia Chanetii* had been already identified as *G. biloba* by Burrett (l. c.).

Grewia abutilifolia Ventenat apud Jussieu in Ann. Mus. Paris, IV. 92 (1804). — Burrett in Notizbl. Bot. Gart. Mus. Berlin, IX. 723 (1926).

Sterculia tiliacea Léveillé in Fedde, Rep. Spec. Nov. XII. 185 (1913); Fl. Kouy-Tchéou, 406 (1915). — **Synon. nov.**

CHINA. Kweichou: canal d'eau en amont de Ouang-mou, *J. Esquirol*, no. 47, May 26, 1904, "arbrisseau, fl. jaunes" (holotype of *Sterculia tiliacea;* photo. in A. A.).

The leaves of the specimen cited are very broad, some even broader than long, about 9 cm. long and 10 cm. broad, and some show a slight tendency toward lobing, as in Henry's no. 9887D which was identified by Burrett (l. c.) with *G. abutilifolia*.

MALVACEAE

Abutilon indicum (L.) Sweet, Hort. Brit. 54 (1827). — Léveillé, Cat. Pl. Yun-Nan, 175 (1916).

Abutilon Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. XII. 185 (1913); Fl. Kouy-Tchéou, 272 (1914). — **Synon. nov.**

CHINA. K w e i c h o u : ouest de Lo-fou, *J. Cavalerie,* Nov. 1905 (holotype of *A. Cavaleriei;* photo. in A. A.).

Urena lobata Linnaeus, Spec. Pl. 692 (1753). — Léveillé, Fl. Kouy-Tchéou, 275 (1914); Cat. Pl. Yun-Nan, 176 (1916).

Abutilon Esquirolii Léveillé in Bull. Géog. Bot. XXIV. 252 (1914); Fl. Kouy-Tchéou, 272 (1914). — **Synon. nov.**

CHINA. K w e i c h o u : Gou-réou, dans les herbages, rare, 700 m., *J. Esquirol,* no. 3668, Sept. 1912, "haut 1.5-2 m., fl. roses" (holotype of *Abutilon Esquirolii;* merotype in A. A.).

A form with ovate to orbicular-ovate undivided only sparingly denticulate leaves and the flowers clustered at the apex of the branches, not axillary along the stems.

Hibiscus Labordei Léveillé in Fedde, Rep. Spec. Nov. XII. 184 (1913); Fl. Kouy-Tchéou, 274 (1914).

CHINA. K w e i c h o u : montagne de Kao-po (Tsin-gay), *J. Laborde* in herb. Bodinier, Sept. 10, 1899 "grand arbuste" (holotype; photo. in A. A.).

This species I have not been able to identify with any of the described species; it seem to be nearest to *H. mutabilis* L. from which it differs chiefly in the 3-lobed leaves, the short pedicels 1-1.5 cm. long, and in the dense ochraceous tomentum of the calyx which is about as long as the 6 linear-lanceolate bracts.

Hibiscus crinitus (Wall.) G. Don, Gen. Syst. I. 480 (1831).

Hibiscus cancellatus Roxburgh, Hort. Bengal. 51 (1814), nom. nud.: Fl. Ind. III. 201 (1832). — Hochreutiner in Ann. Jard. Bot. Genève, IV. 149 (1900). — Léveillé, Cat. Pl. Yun-Nan, 175 (1916). — Non Linnaeus f.

Hibiscus Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. XII. 184 (1913); Fl. Kouy-Tchéou, 274 (1914). — **Synon. nov.**

Hibiscus Bodinieri Léveillé, l. c. (1913); l. c., 273 (1914); Cat. Pl. Yun-Nan, 175 (1916). — **Synon. nov.**

CHINA. K w e i c h o u : montagnes de Lo-fou, *J. Cavalerie,* no. 2584, Nov. 1905 (holotype of *H. Cavaleriei;* photo. in A. A.); Hoa-kiang, *J. Cavalerie,* no. 3959, July 1912 (cited in Fl. Kouy-Tchéou under *H. Cavaleriei;* dupl. in A. A.); Kouy-yang, descente du fleuve, *E. Bodinier,* no. 503, July 27, 1900, "fl. jaunes" (syntype of *H.*

Bodinieri; merotype in A. A.); without locality, *J. Esquirol,* no. 89, June 13, 1904 (syntype of *H. Bodinieri;* photo. in A. A.).

Hibiscus cancellatus Roxb. is a later homonym of *H. cancellatus* Linnaeus f. Suppl. 311 (1781) = *Pavonia cancellata* (L. f.), and also a later synonym of *H. crinitus* (Wall.) G. Don, since its valid publication dates from 1832; therefore, *H. crinitus* (Wall.) G. Don is the correct name for this species.

Hibiscus sagittifolius Kurz var. **septentrionalis** Gagnepain in Lecomte, Fl. Gén. Indo-Chine, I. 435 (1910); Handel-Mazzetti, Symb. Sin. VII. 609 (1933).

Hibiscus Bodinieri var. *brevicalyculata* Léveillé in Fedde, Rep. Spec. Nov. XII. 184 (1913). — **Synon. nov.**

Hibiscus Esquirolii Léveillé, l. c. (1913); Fl. Kouy-Tchéou, 274 (1914).

Hibiscus bellicosus Léveillé, Fl. Kouy-Tchéou, 273 (1914).

China. Kweichou: Kouy-yang, descente du fleuve, *E. Bodinier,* no. 504, July 27, "fl. rouge" (syntype of *H. Bodinieri* var. *brevicalyculata* and holotype of *H. bellicosus;* photo. in A. A.); same locality, *J. Esquirol,* no. 90, June 13, 1904, "fl. rose" (syntype of *H. Bodinieri* var. *brevicalyculata;* photo. in A. A.); montagnes près de Houa-kiang, *J. Cavalerie,* no. 2047, June 1904, and *J. Esquirol,* no. 531, June 1905 (syntypes of *H. Esquirolii;* photo. in A. A.).

Hibiscus Esquirolii has been already referred to this variety by Handel-Mazzetti (l. c.). *Hibiscus bellicosus* was based by *Léveillé* on his *H. Bodinieri* var. *brevicalyculata.*

STERCULIACEAE

Eriolaena malvacea (Lévl.) Handel-Mazzetti, Symb. Sin. VII. 613 (1933).

Sterculia malvacea Léveillé in Fedde, Rep. Spec. Nov. XII. 185 (1913).

Eriolaena sterculiacea Léveillé, Fl. Kouy-Tchéou, 405 (1915).

Eriolaena szemaoensis Hu in Jour. Arnold Arb. v. 230 (1924); in Contrib. Biol. Lab. Sci. Soc. China, 1 no. 2, p. 1 (1925). — **Synon. nov.**

China. Kweichou: Kiao-ta, 750 m., *J. Esquirol,* no. 2185, June 1910 (holotype of *Sterculia malvacea* and *Eriolaena sterculiacea;* photo. in A. A.). Yunnan: Szemao, western mountains, 5000 ft., *A. Henry,* no. 11873 (flowers) "tree 15 ft." (holotype of *E. szemaoensis;* isotype in A. A.); same locality, *A. Henry,* nos. 12506, 12506A, 12506B (fruit) "tree 15 ft." (paratypes of *E. szemaoensis;* isotypes in A. A.).

When transferring his *Sterculia malvacea* to *Eriolaena* Léveillé changed the specific epithet to *"sterculiacea."* The same species was found by Handel-Mazzetti on the road from Yunnan-fu to Talifu (no. 8649).

Reevesia pubescens Masters in Hooker f., Fl. Brit. Ind. I. 364 (1874). — Rehder & Wilson in Sargent, Pl. Wilson. II. 376 (1915). — Léveillé, Cat. Pl. Yun-Nan, 267 (1917). — Anthony in Notes Bot. Gard. Edinb. xv. 124 (1926). — Rehder in Jour. Arnold Arb. x. 196 (1929).

Reevesia Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. IV. 330 (1907); Fl. Kouy-Tchéou, 405 (1915).

Capparis masaikai Léveillé, Fl. Kouy-Tchéou, 59 (1914), pro parte, quoad Cavalerie, no. 3347 [= 2347].

Reevesia thyrsoidea Léveillé, Fl. Kouy-Tchéou 405 (1915). — Non Lindley.

CHINA. K w e i c h o u : route de Pin-fa à Kouy-yang, bois, très rare, *J. Cavalerie,* no. 2347, May 20, 1905 (holotype of *R. Cavaleriei* and syntype of *Capparis masaikai;* merotype in A. A.).

Reevesia Cavaleriei was first identified with *R. pubescens* by Anthony (l. c.), who also reduced *R. sinica* Wils., *R. siamensis* Craib and *Eriolaena yunnanensis* W. W. Sm. to synonyms of *R. pubescens.* Léveillé in his Flore du Kouy-Tchéou made the same number, erroneously cited as no. 3347, one of the two syntypes of his *Capparis masaikai.*

Helicteres glabriuscula Wallich, Num. List. no. 1185 (1828), nom. nud. — M. T. Masters in Hooker f. Fl. Brit. Ind. I. 366 (1874).

Corchorus Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. x. 437 (1912). — **Synon. nov.**

Helicteres Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. XII. 534 (1913); Fl. Kouy-Tchéou, 405 (1915).

CHINA. K w e i c h o u : Lo-fou, *J. Cavalerie,* no. 3470, March 1909 (holotype of *Corchorus Cavaleriei* and *Helicteres Cavaleriei;* merotype in A. A.); Goui-reou, *J. Esquirol,* no. 3180, Dec. 14, 1911, "tout petit frutex" (cited under *Helicteres Cavaleriei;* photo. in A. A.).

This Himalayan species occurs also in Yunnan (Henry, nos. 11185 and 12218A).

DILLENIACEAE

Actinidia purpurea Rehder in Sargent, Pl. Wilson. II. 378 (1915).

Actinidia arguta Planch. (*A. rufa* Miq.) ex Miq. var. *Dunnii* Léveillé, Cat. Pl. Yun-Nan, 269 (1917).

Léveillé cites *"arguta* Dunn" as synonym of his var. *Dunnii* without description or reference to specimens. Dunn's *A. rufa* var. *arguta* is

based on *A. arguta* Miq. and its range is given as including Manchuria, Japan, Korea and China southwest to Yunnan. I assume that Léveillé's intention was to separate as a distinct variety the Yunnan specimens cited by Dunn under var. *arguta*. Dunn cites three specimens from Yunnan, *Delavay*, no. 4264 and *Henry*, nos. 9694 and 11008; the first I have not seen, the two Henry specimens belong to my *A. purpurea*, no. 11008 being cited as a paratype.

Actinidia Fortunati Finet & Gagnepain in Bull. Soc. Bot. France, LIII, 574, fig. 1, 9-16, (1906). — Léveillé, Fl. Kouy-Tchéou, 413 (1915).

Actinidia Dielsii Léveillé in Fedde, Rep. Spec. Nov. XIII. 175 (1914).

CHINA. Kweichou: Pin-fa, montagnes, *J. Cavalerie*, no. 12 bis, June 3, 1902 (syntype of *A. Dielsii;* photo. in A. A.); same locality, *J. Cavalerie*, no. 1746, in 1904 (syntype of *A. Dielsii;* ex Léveillé).

Actinidia Dielsii was referred to *A. Fortunati* by Léveillé in his Flore du Kouy-Tchéou.

Actinidia Rubus Léveillé in Fedde, Rep. Spec. Nov. XII. 282 (1913); Cat. Pl. Yun-Nan, 270 (1917).

CHINA. Yunnan: bois de Sen-choui-lin (Tchao-tong), alt. 2000 m., *E. E. Maire*, June 1912 "arbuste grimpant, rameaux ciliés, fl. jaunes" (holotype; merotype in A. A.).

This species seems nearest to *A. holotricha* Fin. & Gagnep. from which it differs in its larger, ovate to obovate acuminate leaves to 10 cm. long, sparingly setose above, hispid on the midrib beneath and slightly so on the lateral veins, in the 5-6 cm. long petioles and in the sepals being glabrous outside.

Actinidia lanata Hemsley in Ann. Bot. IX. 146 (1895).

Ficus hirtaeformis Léveillé & Vaniot in Mem. Acad. Ci. Art. Barcelona, ser. 3, VI. 150 (reprint, p. 12) (1907); in Fedde, Rep. Spec. Nov. IV. 84 (1907); Fl. Kouy-Tchéou, 430 (1915). — **Synon. nov.**

Mespilus Esquirolii Léveillé in Fedde, Rep. Spec. Nov. XII. 188 (1913); Fl. Kouy-Tchéou, 348 (1915). — **Synon. nov.**

CHINA. Kweichou: Pin-fa, montagnes, *J. Cavalerie*, no. 1593, in 1904 (holotype of *Ficus hirtaeformis;* photo. in A. A.); Pin-fa, ruisseau des barbares, *J. Esquirol*, no. 409, June 1905, "arbrisseau sarmenteux, fl. jaunâtre" (syntype of *Mespilus Esquirolii;* photo. in A. A.); Pin-fa, Niang-ouong, bois, montagnes, *J. Esquirol*, no. 2346, June 8, 1905, "fl. jaune paille, orange" (syntype of *M. Esquirolii;* photo. in A. A.).

According to Handel-Mazzetti (Symb. Sin. VII. 392) Cavalerie, no. 4346, from Pin-fa (in herb. Paris) was determined by Gagnepain as *A. lanata*.

THEACEAE

Thea Costei (Lévl.), comb. nov.

Camellia Costei Léveillé in Fedde, Rep. Spec. Nov. x. 148 (1911); Fl. Kouy-Tchéou, 414 (1915). — C. P. Cohen Stuart in Bull. Gard. Bot. Buitenz. sér. 3, I. 239, 244 (1919).

Thea chinensis Seem. var. *androxantha* Léveillé, Cat. Pl. Yun-Nan, 271 (1917). — **Synon. nov.**

CHINA. Kweichou: Hang-tong, *J. Esquirol*, no. 303, Jan. 26, 1905, "arbrisseau, fl. très blanches, feuillage très vert" (holotype of *Camellia Costei;* merotype in A. A.); Pin-fa, *J. Cavalerie* no. 785, March 6, 1902, "fl. blanches" (cited in Fl. Kouy-Tchéou under *C. Costei;* duplicate in A. A.). Yunnan: brousse de coteaux à Long-ky, alt. 500 m., *E. E. Maire*, May [1911-13], "petit arbre à branches delicates" (holotype of *Thea chinensis* var. *androxantha;* merotype in A. A.).

This species is closely related to *Th. cuspidata* Kochs from which it is chiefly distinguished by the thinner leaves with the veins beneath slightly elevated and by the filaments being united about one half. The specimen of *Th. chinensis* var. *androxantha*, however, resembles in the thicker texture of its leaves *Th. cuspidata*, but the stamens are united, at least partly, to about the middle.

Thea oleosa Loureiro, Fl. Cochinch. 339 (1790). — Merrill, Comm. Lour. Fl. Cochinch. (1921) MS.

Thea oleifera (Abel) Rehder & Wilson in Sargent, Pl. Wilson. II. 393 (1915).

Thea podogyna Léveillé, Sert. Yunnan. 2 (1916); Cat. Pl. Yun-Nan, 271 (1917). — **Synon. nov.**

CHINA. Yunnan: brousse de Tcheng-fong-chan, 800 m., *E. E. Maire*, May 1912, "grande arbuste, toujours vert, fl. blanches" (holotype of *Th. podogyna;* merotype in A. A.).

Thea Grijsii (Hce.) Kochs in Bot. Jahrb. XXVII. 591 (1900).

Thea Cavaleriana Léveillé, Cat. Pl. Yun-Nan, 271, in nota (1917). — **Synon. nov.**

CHINA. Kweichou: Pin-fa, montagnes, *J. Cavalerie*, no. 757, Dec. 9, 1902, "fl. blanches, legèrement roses à l'extérieur" (holotype of *Th. Cavaleriana;* merotype in A. A.).

Thea Pitardii (Stuart) Rehder in Jour. Arnold Arb. v. 238 (1924).

Thea speciosa Pitard apud Diels in Notes Bot. Gard. Edinb. v. 285 (1912). — Non Kochs.

Camellia japonica Léveillé, Fl. Kouy-Tchéou, 414 (1915), tandem pro parte. — Non Linnaeus.

Thea Mairei Léveillé, Sert. Yunnan. 2 (1916); Cat. Pl. Yun-Nan, 271 (1917). — **Synon. nov.**

China. Kweichou: Tou-chan, J. Cavalerie in herb. Bodinier, no. 2594, Aug. 1912 (cited in Fl. Kouy-Tchéou under *C. japonica*, isotype of *Th. speciosa* Pitard apud Diels.). Yunnan: collines de Tchen-fong-chan, 550 m., *E. E. Maire*, May 1912 "arbre de taille moyenne, feuilles luisantes, fl. simple, rouge-vif" (holotype of *Th. Mairei;* merotype in A. A.).

The specimens cited by Léveillé under *Camellia japonica* belong without doubt all to *Thea Pitardii* as does Cavalerie's no. 2594 which is a duplicate of the type of *Th. Pitardii* in the Paris Herbarium. *Thea japonica* (L.) Nois is not found in western China.

As already pointed out by Dr. Handel-Mazzetti (Symb. Sin. VII. 393) *Thea Pitardii* is exceedingly variable in the shape and size of the leaves, in the pubescence of the sepals and also in the color of the flowers, which vary from bright red to white. In the typical form the leaves are generally oblong, 5-10 cm. long and acuminate to long acuminate with the veins above slightly raised and less so beneath; the sepals are densely silky outside and also the petals are more or less silky outside. As an extreme form the following may be distinguished:

Thea Pitardii var. **lucidissima** (Lévl.), comb. nov.

Thea Camellia Lévl. var. *lucidissima* Léveillé, Cat. Pl. Yun-Nan, 270 (1917).

China. Yunnan: montagnes arides herbeuses, autour de Tong-chouan, 2700 m., *E. E. Maire*, Feb. 1912 "arbuste toujours d'un vert luisant" (holotype of *Th. Camellia* var. *lucidissima;* merotype in A. A.).

This variety differs from the typical form in the smaller leaves, usually 3.5-6 cm. long, acute or even obtusish, of thicker texture and usually very lustrous with the veins above mostly impressed, and in the glabrous or glabrescent bracts, sepals and petals. The following specimens in this herbarium from Yunnan seem referable to this variety: Rock, nos. 3045, 3105, 7910, 7941, 8062, 8169, 8469, 11721, 11722 and G. Forrest, nos. 8024 and 26285. In other specimens the leaves are like those of the typical form but the sepals and petals are glabrous or nearly so as in Rock nos. 8237, 8239, 11673 and 11716; these are probably better referred to the type and may constitute a distinct form.

Eurya nitida Korthals, Kruidk. in Verh. Nat. Geschied. Bot. 115, t. 7 (1840). — Handel-Mazzetti, Symb. Sin. VII. 399 (1831).

Rapanea aurea Léveillé in Fedde, Rep. Spec. Nov. x. 376 (1912); Fl. Kouy-Tchéou, 288 (1914). — **Synon. nov.**

CHINA. Kweichou: Pin-fa, montagne, *J. Cavalerie,* no. 839, March 10, and no. 841, Feb. 27, 1902 "fl. blanc-sombres ou blanches" (syntypes of *Rapanea aurea;* photo. in A. A.).

The two specimens differ slightly in the shape of the leaves; no. 839 has oblong leaves with a short but distinct obtuse acumen, while no. 841 has somewhat broader generally elliptic-oblong and not or hardly acuminate leaves.

GUTTIFERAE

Hypericum patulum Thunberg, Fl. Jap. 295 (1784). — Léveillé in Bull. Soc. Bot. France, LIV. 591 (1907); Cat. Pl. Yun-Nan, 133 (1916); in Mem. Acad. Ci. Barcelona, ser. 3, XII. 553 (Cat. Pl. Kiang-Sou, 13) (1916).

Hypericum Argyi Léveillé & Vaniot in Bull. Soc. Bot. France, LIV. 591 (1907); Fl. Kouy-Tchéou, 198 (1914); in Mem. Acad. Ci. Barcelona, ser. 3, XII. 553 (Cat. Pl. Kiang-Sou, 13 (1916). — **Synon. nov.**

CHINA. Kiangsu: without precise locality, *Ch. d'Argy* [1846-66] (holotype of *H. Argyi;* photo. in A. A.). Kweichou: Hoang-tsao-pa, près des cours d'eaux, *J. Esquirol,* no. 1552, June 1909 (cited in Fl. Kouy-Tchéou under *H. Argyi;* merotype in A. A.).

Hypericum Argyi has been already referred to *H. patulum* by G. Koidzumi according to a note on the type specimen. In his key Léveillé (l. c.) distinguishes *H. patulum* from *H. Argyi* chiefly by the acute sepals, but they are obtuse in typical *H. patulum;* they are, however, acute or acutish in *H. patulum* var. *Henryi* Veitch.

Hypericum Hookerianum Wight & Arnott, Prodr. Fl. Ind. 99 (1834). — Léveillé in Bull. Soc. Bot. France, LIV. 590 (1907); Cat. Pl. Yun-Nan, 133 (1916).

Hypericum Henryi Léveillé & Vaniot in Bull. Soc. Bot. France, LIV. 590 (1907). — Léveillé, Fl. Kouy-Tchéou, 198 (1914); Cat. Pl. Yun-Nan, 133 (1916). — **Synon. nov.**

CHINA. Kweichou: environs de Kouy-yang, partout dans les montagnes, *E. Bodinier,* no. 1933, Aug. 1897, "gr. fleurs jaunes" (holotype of *H. Henryi;* photo. in A. A.).

The type specimen of *H. Henryi* cited above bears the name *H. patulum* with a note "d'après Dr. Henry" in Bodinier's handwriting, and the name *H. Henryi* does not appear on the sheet. Two other specimens, however, both from Yunnan and collected by E. E. Maire, bear the name *H. Henryi* in Léveillé's handwriting, but these are not identical with the type of *H. Henryi;* one of these, in the Léveillé

herbarium, is from Tong-tchouan, and the other, in the Herbarium Bonati, "Maire, no. 402, collines, Mai 1905," is without exact locality. Both belong apparently to *H. patulum* var. *Henryi* Veitch, though the leaves resemble those of var. *uralum* (Don) Koehne, but the flowers are quite large, 3-3.5 cm. across and the sepals are acutish to acuminate.

Hypericum longifolium Léveillé in Bull. Agric. Sci. Sarthe, XXXIX. 322 (Bouquet Fl. Chine, 7) (1904); in Fedde, Rep. Spec. Nov. VI. 372 (1909); in Bull. Soc. Bot. France, LIV. 590 (1907); Fl. Kouy-Tchéou, 199 (1914).

CHINA. K w e i c h o u : mont du Collège, dans la brousse, près de Ke-ma-tong, *E. Bodinier,* no. 1774, Aug. 9, 1897 "fl. jaunes" (holotype; photo. in A. A.).

I have not been able to identify *Hypericum longifolium* with a described species. It is similar to *H. chinenese* Lam., but differs in the quadrangular stem, linear-lanceolate gradually acuminate leaves, ovate obtuse sepals and shorter style more deeply divided at the apex, sometimes to 1/3. Léveillé enumerates the species among the frutescent ones, but it has the aspect and the stem of an herbaceous species.

Hypericum kouytchense Léveillé in Bull. Soc. Agric. Sarthe, XXXIX. 322 (Bouquet Fl. Chine 7) (1904); in Bull. Soc. Bot. France, LIV. 592 (1907); in Fedde, Rep. Spec. Nov. VI. 375 (1909); Fl. Kouy-Tchéou, 198 (1914). — Rehder in Jour. Arnold Arb. X. 134 (1929).

CHINA. K w e i c h o u : mont de Lou-tsong-koan, cc. dans la montagne, *E. Bodinier,* no. 1603, May 31, 1897, "belles fleurs jaunes" (holotype; merotype in A. A.).

This species belongs to the section Norysca and seems intermediate between *H. lysimachioides* Wall. and *H. patulum* Thbg. It has been also found near Wushan, eastern Szechuan, and plants raised from seed collected by E. H. Wilson in that locality are in cultivation. At the place cited above I published a description based chiefly on these cultivated plants.

FLACOURTIACEAE

Xylosma racemosum (Sieb. & Zucc.) Miquel in Ann. Mus. Bot. Lugd.-Bat. II. 155 (1865-66). — Léveillé, Fl. Kouy-Tchéou, 52 (1914); Cat. Pl. Yun-Nan, 20 (1915).

Crataegus Academiae Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, XII. 559 (Cat. Pl. Kiang-sou, 19) (1916). — **Synon. nov.**

CHINA. K w a n g s i : Souo-se, *Ch. d'Argy,* Sept. 1859? "arbuste verte" (holotype of *Crataegus Academiae;* merotype in A. A.).

The specimen cited above represents the typical form with glabrous ovate serrulate leaves. I am following Handel-Mazzetti (Symb. Sin. VII. 383) in rejecting as a nomen confusum, Loureiro's name *Croton congestum* on which Merrill based the combination *X. congestum,* since the fruit described is that of an euphorbiaceous plant and the habit given as suffruticose which does not agree with *Xylosma.*

Xylosma racemosum var. **kwangtungense** (Metcalf), comb. nov.

Xylosma Dunniana Léveillé in Fedde, Rep. Spec. Nov. IX. 455 (1911); Fl. Kouy-Tchéou, 52 (1914). — **Synon. nov.**

Flacourtia Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. IX. 457 (1911); Fl. Kouy-Tchéou, 51 (1914). — **Synon. nov.**

Xylosma racemosa Léveillé, Fl. Kouy-Tchéou, 52 (1914), vix Miq.

Xylosma congestum var. *kwangtungense* Metcalf in Jour. Arnold Arb. XII. 272 (1931).

CHINA. K w e i c h o u : Tsin-gai, *J. Cavalerie,* no. 1151, July 15, 1903 (holotype of *X. Dunniana;* merotype in A. A.); Pin-fa, bois, assez rare, *J. Cavalerie,* no. 3327, July 1908, "arbre épineux, fl. jaunes, inodores" (holotype of *Flacourtia Cavaleriei;* merotype in A. A.).

The specimens cited above were referred to by Dr. H. Sleumer (in litt.) to the var. *kwangtungense* with which they agree in their elliptic-oblong to lanceolate-oblong rather coarsely serrate leaves.

Carrierea Dunniana Léveillé in Fedde, Rep. Spec. Nov. IX. 458 (1911); Fl. Kouy-Tchéou, 51 (1914). — Gilg in Engler & Prantl, Nat. Pflanzenfam. ed. 2, XXI. 444 (1925).

CHINA. K w e i c h o u : route de Pin-fa à Tou-yun, *J. Cavalerie,* no. 3001, Aug. 2, 1908, "arbre à fleurs blanches" (holotype; merotype in A. A.).

Carrierea Dunniana has been already enumerated as a valid species by Gilg (l. c.). It is easily distinguished from *C. calycina* Franch. by the many-flowered paniculate inflorescence, the much smaller sepals not cordate at the base, and the ovate-oblong to oblong rather long acuminate leaves. It has been collected also by Y. Tsiang (no. 5644) near Tuyun and distributed as *C. calycina.* As in *C. calycina* the flowers are dioecious, Cavalerie's no. 3001 being pistillate, while Tsiang's no. 5644 is staminate. The ovary of the pistillate flowers is one half to one third as long as the sepals which are about 8 mm. long and is surrounded at the base by anther-bearing staminodes about 1/3 as long as the ovary; the styles are longer and slenderer than in *C. calycina,* about half as long as the ovary. The stamens in the staminate flowers are very numerous and unequal, the longest about one third as long as the sepals, and bear in the middle a minute rudimentary

ovary. The structure of the flowers of *C. calycina* is similar, but in the staminate flowers the rudimentary ovary is lacking or occasionally lacking, at least there was none in a flower examined of Wilson's Veitch Exped. no. 1104. The staminate inflorescence may be occasionally paniculate by its lower branches becoming 3-flowered, while the pistillate inflorescence has fewer flowers and may become reduced to one or two flowers as in a specimen from Tchen-kéou-tin collected by Farges. Among the material in this herbarium I have seen no flower like that figured by Franchet with his original description, but the genus may be polygamous and plants with hermaphrodite flowers may occur.

STACHYURACEAE

Stachyurus yunnanensis Franchet in Jour. de Bot. XII. 253 (1898). — Léveillé, Cat. Pl. Yun-Nan, 270 (1917).

Stachyurus Esquirolii Léveillé, Fl. Kouy-Tchéou, 416 (1915). — **Synon. nov.**

CHINA. K w e i c h o u : Than-lo, 1100 m., *J. Esquirol,* no. 3517, March 20, 1912, "fleurs blanches" (holotype of *S. Esquirolii;* merotype in A. A.).

THYMELAEACEAE

Wikstroemia indica (L.) C. A. Meyer in Bull. Acad. Sci. St. Pétersb. sér. 2, I. 358 (1843).

Wikstroemia Valbrayi Léveillé, Fl. Kouy-Tchéou, 417 (1915); Cat. Ill. Pl. Seu-Tchouen, 199, t. 63 (1918) MS. — Rehder in Sargent, Pl. Wilson. II. 538 (1916). — **Synon. nov.**

CHINA. K w e i c h o u : Tsin-gay, mont., *J. Cavalerie,* no. 1261, Aug. 4, 1903, "fl. jaunes" (syntype of *W. Valbrayi;* photo. in A. A.); route de Pin-fa à Tin-fan, *J. Cavalerie,* no. 1865, Nov. 1904 (syntype of *W. Valbrayi;* photo. in A. A.).

Wikstroemia indica has been collected in Kweichou also by Y. Tsiang (no. 7150), by R. C. Ching in Kwangsi (nos. 6084 and 8172) and by Handel-Mazzetti (no. 10895) who also collected it in Hunan (no. 11297). Handel-Mazzetti cites Cavalerie, no. 1261, a syntype of *W. Valbrayi,* under *W. indica,* but does not quote Léveillé's name as a synonym.

Wikstroemia Vaccinium (Lévl.), comb. nov.

Lonicera Vaccinium Léveillé, Fl. Kouy-Tchéou, 64 (1914).

Frutex ramulis gracilibus sericeo-strigosis, vetustioribus nigro-purpureis. Folia opposita, decidua, breviter petiolata, elliptica vel ovato-elliptica, 5-10 mm. longa, apice obtusiuscula, basi late cuneata, supra glabra, subtus sparse strigosis, utrinque viridia, venis utrinsecus

circiter 3; petioli sericeo-strigosi, vix 1 mm. longi. Flores pauci in spica congesta terminali, pedunculo brevissimo vel in fructu ad 5 mm. longo; perianthii tubus extus sericeo-strigosus, 4 mm. longus, intus glaber, lobis 4 ovatis vix 1 mm. longis, antherae 4 (?), subsessiles; ovarium stipitatum, apice pilis setosis stylum brevem, obtegentibus ceterum glabrum, stigmate capitato; disci squama apice dentata. Fructus ellipsoideus, 4 mm. longus, glaber.

CHINA. K w e i c h o u : Pin-fa, très hautes montagnes, *J. Cavalerie,* no. 26, May 1902 "fl. roses" (holotype of *Lonicera Vaccinium;* merotype in A. A.).

This species seems closely related to *W. monnula* Hance, from which it is easily distinguished by its small obtusish leaves not glaucescent beneath and the longer fruit attenuated at the end. The only flower available for examination was still in bud and probably not fully grown; I noticed only 4 anthers in the flower, the upper whorl being apparently lacking. It may prove to be only a small-leaved variety of *W. monnula,* when more material is available. The species is also related to *W. sericea* Domke, but that species is much more densely silky-pubescent and has larger acute leaves.

I have given above a description of this species, since Léveillé (l. c.) merely says: "*Lonicera Vaccinium* Lévl. nov. sp. Habitus, aspectus, folia *Vaccinii myrtillus;* flores Lonicerae, minimi rosei."

Wikstroemia salicina (Lévl.) Léveillé & Blin in Sargent, Pl. Wilson. II. 535 (1916). — Léveillé, Cat. Pl. Yun-Nan, 272 (1917).

Daphne salicina Léveillé in Bull. Geog. Bot. XXV. 42 (1915).

CHINA. Y u n n a n : paturages du Ié-ma-tchouan, 3200 m., *E. E. Maire,* July 1912 (or 1913), "arbuste buissonnant, haut 1.50 m., fl. jaunes" (holotype of *Daphne salicina;* merotype in A. A.).

In his description under *Daphne,* Léveillé gives the date of collecting as 1912, but under *Wikstroemia* he writes 1913.

Daphne tangutica Maximowicz in Mél. Biol. XI. 309 (1881); in Bull. Acad. Sci. St. Pétersb. XXVII. 531 (1882). — Rehder in Jour. Arnold Arb. IX. 97 (1928).

Daphne Bodinieri Léveillé in Bull. Géog. Bot. XXV. 42 (1915); Cat. Pl. Yun-Nan, 271 (1917); non Léveillé (1914). — **Synon. nov.**

Daphne Wilsonii Rehder in Sargent, Pl. Wilson. II. 540 (1916).

CHINA. Y u n n a n : haut plateau de Ta-hai-tse, *E. E. Maire,* May 1912 (holotype of *D. Bodinieri;* photo. in A. A.).

In 1916 Léveillé sent me fragments of the specimen cited above which I identified as *D. Wilsonii;* in consequence, Léveillé crossed out *D. Bodinieri* on his type specimen and labelled it *D. Wilsonii.* The

plant described by Léveillé under the same name the year before is a species of *Melodinus*.

Daphne papyracea Wallich apud Steudel, Nomencl. ed. 2, I. 483 (1841), nomen. — Meisner in Denkschr. Regensb. Bot. Ges. III. 282 (1841). — Rehder in Sargent, Pl. Wilson. II. 546 (1916). — Léveillé, Cat. Pl. Yun-Nan, 272 (1917).

Daphne papyrifera Hamilton ex D. Don, Fl. Nepal. 68 (1825), pro synon. — Léveillé, Fl. Kouy-Tchéou, 416 (1915).

Daphne Mairei Léveillé in Bull. Géog. Bot. xxv. 41 (1915); Cat. Pl. Yun-Nan, 271 (1917). — **Synon. nov.**

Daphne Cavaleriei Léveillé, l. c. 42 (1915); l. c. (1917). — **Synon. nov.**

China. Yunnan: sous bois des montagnes à Ta-tchai, 3000 m., *E. E. Maire,* April 1912, "arbrisseau toujours vert, haut 0.40 m., fl. roses" (holotype of *D. Mairei;* photo. in A. A.); brousse de Lan-ngi-tsin, 2600 m., *E. E. Maire,* March 1912, "arbuste toujours vert, fl. blanches odorantes" (holotype of *D. Cavaleriei;* photo. in A. A.).

As in the case of the preceding species Léveillé sent me in 1916 fragments of *D. Mairei* and *D. Cavaleriei* which I identified as *D. papyracea* and this name was added later by Léveillé to the type specimens of his two species. In his Catalogue des plantes du Yun-Nan, however, he lists both as distinct species and cites *D. Martini* as a synonym of *D. papyracea*.

Daphne Feddei Léveillé in Fedde, Rep. Spec. Nov. IX. 326 (1911); Fl. Kouy-Tchéou, 416 (1915). — Rehder in Sargent, Pl. Wilson. II. 547 (1916).

Daphne Martini Léveillé in Fedde, Rep. Spec. Nov. x. 369 (1912); Fl. Kouy-Tchéou, 416 (1915).

China. Kweichou: without precise locality, *J. Cavalerie,* no. 101 (holotype of *D. Feddei;* photo. in A. A.); environs de Kouy-yang, mont du Collège, *J. Chaffanjon* in hb. E. Bodinier, no. 2076, Feb. 1898 (syntype of *D. Martini;* photo. in A. A.); environs de Gan-pin, grandes rocailles, *L. Martin* in hb. Bodinier, no. 2076, Feb. 1898 (syntype of *D. Martini;* photo. in A. A.); Yeou-lang, *J. Esquirol,* no. 775 (syntype of *D. Martini;* merotype in A. A.).

Bodinier no. 2076 represents a vigorous branch with many additional axillary inflorescences.

Daphne Esquirolii Léveillé in Bull. Géog. Bot. xxv. 42 (1915); Cat. Pl. Yun-Nan, 271 (1917).

Daphne leuconeura Rehder in Sargent, Pl. Wilson. II. 548 (1916).

Daphne leuconeura var. *Mairei* Rehder & Léveillé in Sargent, Pl. Wilson. II. 548 (1916). — Léveillé in Pl. Yun-Nan, 271 (1917).

Wikstroemia leuconeura (Rehd.) Domke in Notizbl. Bot. Gart. Mus. Berlin, XI. 363 (1932).

CHINA. Western Szechuan: Tung River valley, alt. 700 m., *E. H. Wilson,* Veitch Exped. no. 4431, May 1904, "3-4 ft., flowers yellow" (holotype of *D. leuconeura* in A. A.). Yunnan: monts derrière Mongkou, alt. 2000 m., *E. E. Maire,* March 1912 (holotype of *Daphne Esquirolii* and *D. leuconeura* var. *Mairei;* photo. and fragments in A. A.); in dumetis inter flum. Salween et Mekong, alt. 2500-3000 m., *C. Schneider,* no. 2614, Oct. 1914; on boulders and cliffs in the Mekong valley, alt. 4-5000 ft., Lat. 25° 16′ N., *G. Forrest,* no. 13716, April 1917, "shrub of 3-4 ft., flowers light orange yellow"; without precise locality, *G. Forrest,* no. 9895.

When Léveillé sent me a fragment of the specimen cited above with the suggestion that it should be named after E. E. Maire, I did not know of his previous publication of *Daphne Esquirolii* based on the same specimen. I referred it to my new species *D. leuconeura* as a variety, since the very young leaves had a slight pubescence and the whole aspect of the plant was different on account of the precocious flowering in March. All the other specimens cited above were collected later and have fully developed leaves, but Forrest's specimens show below the terminal flowering inflorescence on the same sympodial shoot one or two older inflorescences with the flowers dropped which must have shown when in bloom a condition similar to Maire's specimen having young inflorescences with the lower small leaves scarcely half grown. The slight pubescence of these young leaves probably disappeared later entirely.

Léveillé in his Catalogue des plantes du Yun-nan cites both, *D. Esquirolii* and *D. leuconeura* var. *Mairei,* as valid names.

Stellera chamaejasme Linnaeus, Spec. Pl. 559 (1753).

Stellera Bodinieri Léveillé in Fedde, Rep. Spec. Nov. x. 369 (1912); Fl. Kouy-Tchéou, 417 (1915); Cat. Pl. Yun-Nan, 272 (1917). — **Synon. nov.**

Wikstroemia chamaejasme (L.) Domke in Notizbl. Bot. Gard. Mus. Berlin, XI. 362 (1932).

CHINA. Kweichou: montagnes entre Hin-y-hien et Hin-y-fou, *E. Bodinier,* April 12, 1897, "belles fl. jaunes" (syntype of *S. Bodinieri;* photo. in A. A.). Yunnan: environs de Yun-nan-sen, haut des montagnes, March 19, 1897, montagnes entre Ma-kay et Se-hong, April 9, 1897, *F. Ducloux,* "belles fl. jaunes" (syntypes of *S. Bodinier;* photo. in A. A.).

The three specimens cited by Léveillé under his *S. Bodinieri* differ in the shape of their leaves; Bodinier's specimen has elliptic leaves

about 1 cm. broad, while Ducloux's specimens have narrower leaves, oblanceolate and about 5-6 mm. broad in one and linear and about 2 mm. broad in the other. All three are mounted on the same sheet.

I have here retained *Wikstroemia* and *Stellera* as distinct genera, though Domke gives good reasons for uniting the species of the section *Chamaestellera* and of *Wikstroemia,* while he recommends keeping *Dendrostellera* Van Tiegh. (C. A. Mey. as section of *Stellera*) as a distinct genus. In uniting the two genera Domke places all the species under *Wikstroemia,* because the latter is a nomen conservandum. This, however, is hardly in accordance with art. 46 of the Rules; if Domke's interpretation were correct, then all the species of *Berberis* would have to be transferred to *Mahonia* if the two genera are united, because the latter is a conserved name, and for the same reason, if *Spiraea* and *Sorbaria* should be again united, all the species of *Spiraea* should be transferred to *Sorbaria.* This would nullify the reason for which nomina conservanda were adopted, namely to avoid disadvantageous changes in nomenclature.

LYTHRACEAE

Woodfordia fruticosa (L.) S. Kurz in Jour. As. Soc. Beng. XL.-2, p. 56 (1871). — Koehne in Engler, Pflanzenr. IV.-216, p. 79, fig. 12 (1903). — Handel-Mazzetti, Symb. Sin. VII. 593 (1933).

Lonicera androsaemifolia Léveillé, Fl. Kouy-Tchéou, 62 (1914).

China. Kweichou: Lo-fou, *J. Cavalerie,* no. 3487, March 1909 (holotype of *Lonicera androsaemifolia;* merotype in A. A.).

Lonicera androsaemifolia was first identified with *Woodfordia fruticosa* by Handel-Mazzetti (l. c.).

NYSSACEAE

Nyssa sinensis Oliver in Hooker's Icon. XX. t. 1964 (1891).

Daphniphyllum Cavalerici Léveillé in Fedde, Rep. Spec. Nov. IX. 460 (1911); Fl. Kouy-Tchéou, 161 (1914). — K. Rosenthal in Engler, Pflanzenr. IV.-147a, p. 15 (1919). — **Synon. nov.**

Microrhamnus Bodinieri Léveillé, Fl. Kouy-Tchéou, 341 (1915). — **Synon. nov.**

China. Kweichou: Pin-fa, montagnes, *J. Cavalerie,* nos. 2319, 2349, April 26 and May 30, 1905 "arbre de 7 ou 8 m." (syntypes of *Daphniphyllum Cavaleriei,* photos. in A. A.); same locality, *J. Cavalerie,* nos. 1093 and 2381, June 23, 1903 and June 15, 1905 (syntypes of *Microrhamnus Bodinieri;* photo. and merotype in A. A.).

This species has been collected in Kweichou also by Y. Tsiang (no. 5944) at Yunfushan, Tuyun, in 1930.

ALANGIACEAE

Alangium Faberi Oliver in Hooker's Icon. xviii. t. 1774 (1888). — Léveillé, Cat. Pl. Yun-Nan, 59 (1916). — Melchior in Notizbl. Bot. Gard. Mus. Berlin, x. 823 (1929).

Marlea Bodinieri Léveillé in Bull. Acad. Géog. Bot. xxii. 232 (1912); Fl. Kouy-Tchéou, 116 (1914). — **Synon. nov.**

China. Kweichou: environs de Tou-chan, *E. Bodinier* & *J. Cavalerie*, no. 2666, June 27, 1899 (holotype of *Marlea Bodinieri;* photo. in A. A.).

The leaves of *A. Faberi* are almost invariably undivided, but a detached leaf of Bodinier's no. 2666 is deeply three-lobed; the only other specimen in this herbarium with a three-lobed leaf is Wilson's no. 4505.

Alangium Faberi var. **perforatum** (Lévl.), comb. nov.

Ardisia perforata Léveillé in Fedde, Rep. Spec. Nov. ix. 462 (1911); Fl. Kouy-Tchéou, 283 (1914).

China. Kweichou: environs de Gan-pin, dans les grandes rocailles près de la ville, rare, *L. Martin & E. Bodinier*, no. 1632, June 10, 1897, "fl. jaunâtres" (holotype of *Ardisia perforata;* photo. in A. A.).

This variety differs from the type in the much smaller and narrower leaves, 4-7 cm. long and 5-8 mm. broad, rounded to broad-cuneate and nearly equal at the base, more strongly veined beneath and in the rufous pubescence of the branchlets and inflorescence; it seems to be a more compact plant with rather short branchlets. Intermediate forms are R. C. Ching, no. 6337 from Kwangsi, and also judging from Handel-Mazzetti's description (Symb. Sin. vii. 684) Handel-Mazzetti, no. 10516, from Kweichou which I have not seen.

COMBRETACEAE

Combretum Wallichii De Candolle, Prodr. iii. 21 (1828). — Exell in Sunyatsenia, i. 87 (1933).

Aspidopterys Cavaleriei Léveillé, Fl. Kouy-Tchéou, 271 (1914), quoad specimina citata; non Léveillé (1911).

Terminalia Mairei Léveillé, Cat. Pl. Yun-Nan, 35 (1915).

China. Kweichou: rochers à 30 kilom. au sud de Tin-fan, *J. Cavalerie*, no. 1882, Sept. 1904 (cited in Fl. Kouy-Tchéou under *Aspidopterys Cavaleriei;* photo. in A. A.); without precise locality, *J. Esquirol*, no. 712 (cited in Fl. Kouy-Tchéou under *Aspidopterys Cavaleriei;* photo. in A. A.). Yunnan: montagnes de Pe-long-tsin, 3200 m., *E. E. Maire*, June 1912 (holotype of *Terminalia Mairei;* merotype in A. A.).

Terminalia Mairei was first identified with *C. Wallichii* by Exell (l. c.). As I pointed out under *Aspidopterys Cavaleriei* (Jour. Arnold Arb. XIV. 228) Léveillé cites in his Flore du Kouy-Tchéou the type of *A. Cavaleriei* under *A. Dunniana* and refers to *A. Cavaleriei* two fruiting specimens which do not belong to *Aspidopterys*, but represent *Combretum*.

MYRTACEAE

Decaspermum fruticosum Forster, Char. Gen. 74, t. (1776).

Eugenia Esquirolii Léveillé in Fedde, Rep. Spec. Nov. IX. 459 (1911); Fl. Kouy-Tchéou, 289 (1914). — **Synon. nov.**

Pirus Bodinieri Léveillé, Fl. Kouy-Tchéou, 350 (1915). — **Synon. nov.**

CHINA. K w e i c h o u : hauteur de Lao-ten, *J. Esquirol*, no. 82, June 1904 "grand arbrisseau, fl. roses" (holotype of *Eugenia Esquirolii;* merotype in A. A.); chemin de Lo-hou à Tong-tchéou, *J. Esquirol*, no. 3611, June 10, 1912 (holotype of *Pirus Bodinieri;* merotype in A. A.).

Eugenia Esquirolii and *Pirus Bodinieri* were determined as *Decaspermum fruticosum* by Dr. E. D. Merrill, to whom I had sent specimens for identification. This very widely distributed Malaysian species had not yet been recorded as far north as Kweichou. The only other Chinese specimens we have in this herbarium are all more southern and came from Hainan (Canton Christ. Coll. 8628 and Lingnan Univ. 15772), Kwangtung (Y. Tsiang 2186) and Szemao, S. Yunnan (Rock 2787 and 2832).

MELASTOMACEAE

Melastoma normale D. Don, Prodr. Fl. Nepal. 220 (1825). — Guillaumin in Lecomte, Not. Syst. II. 319 (1913). — Léveillé, Fl. Kouy-Tchéou, 277 (1914); Cat. Pl. Yun-Nan, 176 (1916). — Rehder & Wilson in Sargent, Pl. Wilson. II. 421 (1915).

Melastoma Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. III. 21 (1906).

Melastoma Esquirolii Léveillé, op. cit. VIII. 61 (1910).

CHINA. K w e i c h o u : route de Tchen-lin à Mou-you-se, *J. Cavalerie*, no. 2161, May 25, 1904 "fl. rose pale" (holotype of *M. Cavaleriei;* photo. in A. A.); without precise locality, *J. Esquirol*, no. 873, June 1906, "fl. rouge" (syntype of *M. Esquirolii;* photo. in A. A.); steppes, Hoang-tsao-pa, *J. Esquirol*, no. 1538, June 1909 (syntype of *M. Esquirolii;* photo. in A. A.).

Melastoma Cavaleriei and *M. Esquirolii* were first identified with *M. normale* by Guillaumin (l. c.).

Osbeckia crinita, Bentham apud Wallich, Num. List. no. 4066 (1829), nom. nud. — C. B. Clarke in Hooker f., Fl. Brit. Ind. II. 517

(1879). — Guillaumin in Lecomte, Not. Syst. II. 308 (1913. — Rehder & Wilson in Sargent, Pl. Wilson. II. 422 (1915). — Non Naudin.

Melastoma Mairei Léveillé in Fedde, Rep. Spec. Nov. XI. 300 (1912).

Osbeckia crinita Benth. var. *yunnanensis* Cogniaux in De Candolle, Monog. Phan. VII. 324 (1891). — Léveillé, Fl. Kouy-Tchéou, 277 (1914); Cat. Pl. Yun-Nan, 176 (1916).

CHINA. Yunnan: Tchouan-se-pa, 650 m., vallées et collines herbeuses, *E. E. Maire,* June 1911, "fl. rouges, grandes" (holotype of *Melastoma Mairei;* photo. in A. A.).

Melastoma Mairei was first identified with *Osbeckia crinita* by Guillaumin (l. c.) who groups the Chinese plants under var. *yunnanensis,* but Handel-Mazzetti (Symb. Sin. VII. 597) says and I agree that there is no difference between the Indian and the Chinese plants.

Plagiopetalum Esquirolii (Lévl.), comb. nov.

Sonerila Esquirolii Léveillé in Bull. Soc. Bot. France, LIV. 368 (1907); in Fedde, Rep. Spec. Nov. XI. 494 (1913).

Barthea Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. VIII. 61 (1910), pro parte, quoad Esquirol no. 215.

Barthea Blinii Léveillé in Fedde, Rep. Spec. Nov. XI. 494 (1913).

Allomorphia Blinii (Lévl.) Guillaumin in Bull. Soc. Bot. France, LX. 87 (1913). — Léveillé, Fl. Kouy-Tchéou 276, (1914).

Plagiopetalum quadrangulum Rehder in Sargent, Pl. Wilson. III. 453 (1917).

Plagiopetalum serratum (Diels) Diels in Bot. Jahrb. LXV. 100 (1932).

CHINA. Kweichou: Hoa-ouan-yao, *J. Esquirol,* no. 645, Aug. 1905 (holotype of *Sonerila Esquirolii* of 1907; ex Léveillé et ex Diels); without precise locality, *J. Esquirol,* no. 644, in 1906 (holotype of *S. Esquirolii* of 1913 ex Léveillé et ex Guillaumin); anfractuosités du pic de Ko-tchang-kéou, *J. Esquirol,* no. 215, Sept. 1904 "pied unique" (syntype of *Barthea Cavaleriei* and holotype of *Barthea Blinii;* photo. in A. A.).

I have not seen the types of the two specimens described independently as *Sonerila Esquirolii,* each name being based on a different type. Guillaumin (l. c.) cites only no. 644, the type of the *Sonerila Esquirolii* of 1913, but Diels (l. c.) cites both, 644 and also 645, the type of the *Sonerila Esquirolii* of 1907, which shows that the two are conspecific. Also Léveillé in Flore du Kouy-Tchéou cites both specimens under *Allomorphia Blinii.* Diels apparently overlooked the earlier publication and therefore based his new combination on his *Oxyspora serrata* of 1912.

Oxyspora paniculata De Candolle, Prodr. III. 123 (1828). — Léveillé, Cat. Pl. Yun-Nan, 176 (1916). — Diels in Bot. Jahrb. LXV. 104 (1932).

Bredia soneriloides Léveillé in Fedde, Rep. Spec. Nov. IX. 21 (1910). *Sonerila Cavaleriei* Léveillé in herb., l. c. (1910), pro synon. *Brediae soneriloidis;* XI. 494 (1913).

CHINA. Kweichou: Lo-fou, *J. Cavalerie,* no. 3645, Oct. 1908 (holotype of *Bredia soneriloides;* ex Léveillé et ex Diels); près de chemin entre Pien-yang et Lo-fou, *J. Cavalerie,* no. 2681 (holotype of *Sonerila Cavaleriei;* ex Léveillé et ex Diels).

Bredia soneriloides and *Sonerila Cavaleriei* have been identified with *Oxyspora paniculata* by Diels (l. c.). Léveillé in 1910 quotes *Sonerila Cavaleriei* as a synonym of *Bredia soneriloides,* but in 1913 he describes it as a distinct species based on a different specimen, though the description reveals no characters to distinguish it from *Bredia soneriloides.* I have not seen the specimens cited above.

Blastus cochinchinensis Loureiro, Fl. Cochinch. 526 (1790). — Guillaumin in Bull. Soc. Bot. France, LX. 89 (1913). — Léveillé, Fl. Kouy-Tchéou, 276 (1914). — Diels in Bot. Jahrb. LXV. 105 (1932).

Blastus Marchandii Léveillé in Fedde, Rep. Spec. Nov. XI. 494 (1913).

CHINA. Kweichou: Tchang-loy, *J. Esquirol,* no. 967, June 1906 "arbrisseau, 3 m. hauteur, fleur rouge" (holotype of *B. Marchandii;* photo. in A. A.).

Blastus Marchandii was first identified with *B. cochinchinensis* by Guillaumin and this identification was adopted by Léveillé in his Flore du Kouy-Tchéou.

Blastus pauciflorus (Benth.) Guillaumin in Bull. Soc. Bot. France, LX. 90 (1913). — Léveillé, Fl. Kouy-Tchéou, 276 (1914). — Diels in Bot. Jahrb. LXV. 107 (1932).

Blastus Cavaleriei Léveillé & Vaniot in Mém. Soc. Nat. Sci. Nat. Cherbourg, XXXV. 395 (1906); in Fedde, Rep. Spec. Nov. IV. 94 (1907).

Allomorphia Bodinieri Léveillé in Fedde, Rep. Spec. Nov. V. 100 (1908).

Bredia Bodinieri Léveillé, l. c. (1908), pro synon.

CHINA. Kweichou: environs de Tou-chan, *J. Cavalerie* in hb. Bodinier, no. 2676, June 27, 1899, "arbrisseau, fl. roses" (holotype of *B. Cavaleriei* and of *Allomorphia Bodinieri;* photo. in A. A.).

Blastus Cavaleriei was first identified with *B. pauciflorus* by Guillaumin and cited by Léveillé in his Flore du Kouy-Tchéou under the latter name; both cite an additional number, 2170, from the same locality.

Blastus Dunnianus Léveillé in Fedde, Rep. Spec. Nov. IX. 449 (1911); Fl. Kouy-Tchéou, 276 (1914). — Guillaumin in Bull. Soc. Bot. France, LX. 91 (1913). — Diels in Bot. Jahrb. LXV. 107 (1932).

CHINA. Kweichou: Ma-jo, rare, *J. Cavalerie*, no. 2971, July 1908, "arbrisseau, 1 à 2 m., fl. roses" (holotype; merotype in A. A.).

Notes on herbaceous Melastomaceae described by Léveillé and critically examined by Guillaumin and by Diels, of which I have seen no specimens, may be appended here.

Bredia Cavaleriei (Lévl.) Diels in Bot. Jahrb. LXV. 110 (1932). — Handel-Mazzetti, Symb. Sin. VII. 599 (1933).

Barthea Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. VIII. 61 (1910), quoad specimen Cavalerie, no. 1552.

Fordiophyton Cavaleriei (Lévl.) Guillaumin in Bull. Soc. Bot. France, LX. 275 (1913), quoad typum. — Léveillé, Fl. Kouy-Tchéou, 276 (1914), quoad typum.

Fordiophyton Cavaleriei var. *violacea* Léveillé, Cat. Pl. Yun-Nan, 176 (1916), nom. nud.

CHINA. Kweichou: *Cavalerie*, no. 1552 (holotype of *Barthea Cavaleriei;* ex Léveillé, Guillaumin, Diels).

Guillaumin mentions as probably belonging here *Barthea Esquirolii* Léveillé, Fl. Kouy-Tchéou, 276. 1914, pro synon. (*B. Cavaleriei* Léveillé in Fedde, Rep. Spec. Nov. VIII. 61. 1910; pro parte, quoad specim. Esquirol, no. 1581), but Diels says that the specimen is too incomplete to be determined.

Bredia yunnanensis (Lévl.) Diels in Bot. Jahrb. LXV. 111 (1932).

Blastus yunnanensis Léveillé in Fedde, Rep. Spec. Nov. XI. 300 (1912).

Blastus Mairei Léveillé, l. c. (1912).

Fordiophyton Cavaleriei (Lévl.) Guillaumin in Bull. Soc. Bot. France, LX. 275 (1913), pro parte, quoad specim. e Yunnan.

CHINA. Yunnan: Long-ky, *E. E. Maire*, Aug. 1911 (holotype of *Blastus yunnanensis;* ex Léveillé, Guillaumin, Diels); same locality, *E. E. Maire*, June 1911 (holotype of *Blastus Mairei;* ex Léveillé, Guillaumin).

Diels (l. c.) expresses doubt that *B. Mairei* belongs here.

Fordiophyton Faberi Stapf in Ann. Bot. VI. 314 (1892). — Guillaumin in Bull. Soc. Bot. France, LX. 274 (1913). — Léveillé in Fl. Kouy-Tchéou, 276, (1914). — Diels in Bot. Jahrb. LXV. 114 (1932).

Bredia Cavaleriei Léveillé & Vaniot in Mém. Soc. Nat. Sci. Nat. Cherbourg, XXXV. 396 (1906); in Fedde, Rep. Spec. Nov. IV. 94 (1907).

Oxyspora Cavaleriei Léveillé in herb., l. c. (1906) and (1907), pro synon. *Brediae Cavaleriei.*

Bredia Mairei Léveillé in Fedde, Rep. Spec. Nov. XI. 300 (1912).

Blastus Lyi Léveillé, l. c. 301 (1912).

CHINA. Kweichou: Tou-chan, *J. Cavalerie* (holotype of

Bredia Cavaleriei; ex Léveillé, Guillaumin); Pin-fa à Tou-yun, *J. Cavalerie,* no. 2977 (holotype of *Blastus Lyi,* ex Léveillé, Guillaumin). Yunnan: Long-ky, *E. E. Maire,* June 1911 (holotype of *Blastus Mairei;* ex Léveillé, Guillaumin).

Phyllagathis Cavaleriei (Lévl. & Vant.) Guillaumin in Bull. Soc. Bot. France, LX. 273 (1913).—Léveillé, Fl. Kouy-Tchéou, 277 (1914).—Diels in Bot. Jahrb. LXV. 115 (1932).

Allomorphia Cavaleriei Léveillé & Vaniot in Mém. Soc. Nat. Cherbourg, XXXV. 394 (1906); in Fedde, Rep. Spec. Nov. IV. 94 (1907).

Oxyspora Cavaleriei Léveillé in herb., l. c. (1906 and 1907), pro synon. *Allomorphiae Cavaleriei.*

China. Kweichou: *J. Cavalerie,* no. 2675 (syntype of *Allomorphia Cavaleriei;* ex Léveillé, Diels); *J. Cavalerie,* no. 56 (syntype of *A. Cavaleriei,* ex Léveillé, Guillaumin); *J. Cavalerie,* no. 246 (syntype of *A. Cavaleriei;* ex Léveillé, Diels).

ARALIACEAE

Trevisia palmata (Roxb.) Visiani in Mem. Accad. Torin. ser. 2, IV. 262, pl. (1842).—Léveillé, Cat. Pl. Yun-Nan, 11 (1915).

Fatsia Cavaleriei Léveillé in Bull. Géog. Bot. XXIV. 144 (1914); Fl. Kouy-Tchéou, 34 (1914).—**Synon. nov.**

China. Kweichou: Houa-kiang, *J. Cavalerie,* no. 2144, June 6, 1904, "h. 3 m." (holotype of *Fatsia Cavaleriei;* photo. in A. A.).

Tetrapanax papyrifera (Hook.) K. Koch in Wochenschr. Gaertn. Pflanzenk. II. 371 (1859).

Fatsia papyrifera (Hook.) Nicholson, Ill. Dict. Gard. II. 3 (1887).—Léveillé, Fl. Kouy-Tchéou, 34 (1914); Cat. Pl. Yun-Nan, 11 (1915).

Aralia Mairei Léveillé in Fedde, Rep. Spec. Nov. XIII. 342 (1914); Fl. Kouy-Tchéou, 34 (1914); Cat. Pl. Yun-Nan, 11 (1915).—**Synon. nov.**

China. Kweichou: Ting-tsao, *J. Esquirol,* no. 678 (cited in Fl. Kouy-Tchéou under *Aralia Mairei;* ex Léveillé). Yunnan: vallée de Lin-kiang-ki, 700 m., *E. E. Maire,* Nov. 1913, "arbuste poreux à tronc denudé, haut 1.50 m., feuilles terminales, tomenteuses, blanches en dessous, fl. grises, faisceaux de grappes dressés" (holotype of *A. Mairei;* merotype in A. A.).

Schefflera Delavayi (Franch.) Harms in Bot. Jahrb. XXIX. 486 (1900).

Heptapleurum Delavayi Franchet in Jour. de Bot. X. 307 (1896).—Léveillé, Cat. Pl. Yun-Nan, 11 (1915).

Heptapleurum Dunnianum Léveillé in Fedde, Rep. Spec. Nov. XI. 295 (1912); Fl. Kouy-Tchéou, 35 (1914).—**Synon. nov.**

CHINA. K w e i c h o u : environs de Kouy-yang, dans la montagne près du Collège, *E. Bodinier*, no. 2506, Sept. 1898 (holotype of *H. Dunnianum;* photo. in A. A.).

Léveillé compares his *Heptapleurum Dunnianum* with *H. Delavayi* Franch. and says it differs from it in "foliis dimorphis usque 7-foliolatis membranaceis nec lucidis," but all these characters apply as well to *H. Delavayi.*

Schefflera Bodinieri (Lévl.) Rehder in Jour. Arnold Arb. XI. 166 (1930).

Heptapleurum Bodinieri Léveillé in Fedde, Bull. Géog. Bot. XXIV. 144 (1914); Fl. Kouy-Tchéou, 35 (1914).

CHINA. K w e i c h o u : district de Tsin-gay, vallée de Kia-la-tchang, *J. Laborde* in herb. Bodinier, no. 2459, Dec. 21, 1897, "grand arbuste" (syntype; merotype in A. A.); environs de Kouy-yang, mont du Collège, *E. Bodinier,* Feb. 17 and Sept. 1898 (syntypes; ex Léveillé); route de Pin-fa à Kouy-tin, *J. Cavalerie,* no. 3098 in part, Dec. 4, 1902 (syntype; ex Léveillé); Long-ly, *J. Cavalerie,* nos. 1567 and 3098 in part, Sept. 1907 (cited in Fl. Kouy-Tchéou; duplicate of no. 1567 and photo. of no. 3098 in A. A.).

Schefflera elliptica (Bl.) Harms in Engler & Prantl, Nat. Pflanzenfam. III.-8, p. 39 (1894).

Heptapleurum Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. IX. 326 (1911); Fl. Kouy-Tchéou, 35 (1914). — **Synon. nov.**

CHINA. K w e i c h o u : ouest de Lo-fou, rivière de Pia-nai, *J. Cavalerie,* no. 2658, Nov. 5, 1905, "petit arbre" (holotype of *Heptapleurum Cavaleriei;* photo. in A. A.).

Cavalerie's no. 2658 has the leaves somewhat less prominently reticulate than most of the specimens before me, but in all other characters the specimen which is in fruit agrees well with the Chinese, Indian and Malaysian material before me. I am unable to see any constant characters to separate *S. elliptica* from *S. venulosa* (Wight & Arn.) Harms and follow C. B. Clarke, Viguier and Handel-Mazzetti in uniting the two.

Schefflera spec.

Acanthopanax Esquirolii Léveillé in Bull. Géog. Bot. XXIV. 143 (1914); Fl. Kouy-Tchéou, 33 (1914).

CHINA. K w e i c h o u : district de Tin-fan, *J. Cavalerie,* 1847 bis, Nov. 1914 (holotype of *Acanthopanax Esquirolii;* merotype in A. A.).

Acanthopanax Esquirolii seems to be related to *S. octophylla* (Lour.) Harms. but is readily distinguished by the remotely serrulate leaflets.

The slender-pedicelled flowers are borne in many flowered long-peduncled umbels which seem to form large panicles; the inflorescence is sparingly stellate-pubescent; the style is about one mm. long. It may be a new species, but the material is too fragmentary for a satisfactory description.

Schefflera spec.

Eleutherococcus Bodinieri Léveillé in Bull. Géog. Bot. XXIV. 144 (1914); Fl. Kouy-Tchéou, 33 (1914).

China. Kweichou: district de Tsin-gay, vallée de Kia-la-tchang, *J. Laborde* in hb. Bodinier, Dec. 21, 1897, "grand arbuste" (holotype of *Eleutherococcus Bodinieri;* photo. in A. A.).

Eleutherococcus Bodinieri apparently belongs to *Schefflera* and may be related to *S. Bodinieri* (Lévl.) Rehd., but the leaves are 3—6-foliolate and the leaflets are elliptic to oblong; the broader leaflets are mostly remotely and rather coarsely dentate toward the apex, while the narrower ones are entire. It may be a new species, but as I have only a photograph and not the original specimen before me, I have to leave the question open.

Brassaiopsis ciliata Dunn in Jour. Linn. Soc. Bot. XXXV. 499 (1903).

Acanthopanax Bodinieri Léveillé in Bull. Géog. Bot. XXIV. 143 (1914); Fl. Kouy-Tchéou, 33 (1914). — **Synon. nov.**

China. Kweichou: environs de Gan-pin, plante rare, pousse dans le fond d'une profonde depression sombre et humide en forme de Tong, *L. Martin* in hb. Bodinier, no. 1928, Oct. 24, 1897, "tige sous-ligneuse, de 1 m. de haut, fl. blanches" (holotype of *Acanthopanax Bodinieri;* photo. in A. A.).

Brassaiopsis tripteris (Lévl.), comb. nov.

Heptapleurum tripteris Léveillé in Bull. Géog. Bot. XXIV. 145 (1914); Fl. Kouy-Tchéou, 35 (1914); Cat. Ill. Pl. Seu-Tchouen, pl. 1 (1918) MS.

China. Kweichou: ouest de Lo-fou, bois, *J. Cavalerie,* no. 2566, Nov. 1905 (holotype of *Heptapleurum tripteris;* merotype in A. A.).

Brassiopsis tripteris is a very distinct species. In habit it resembles *B. ficifolia* Dunn, but is even lower; the leaves are tripartite to the base, or sometimes as in the specimen before me with an additional small basal lobe, and are conspicuously spinose-serrulate, the leaflets ending into a long slender acumen not shown in the figure cited above.

Nothopanax Delavayi (Franch.) Harms in Bot. Jahrb. XXIX. 488 (1900).

Panax Delavayi Franchet in Jour. de Bot. x. 305 (1896). — Léveillé, Cat. Pl. Yun-Nan, 11 (1915).

Aralia Bodinieri Léveillé in Bull. Géog. Bot. XXIV. 143 (1914); Fl. Kouy-Tchéou, 34 (1914). — **Synon. nov.**

Heptapleurum Esquirolii Léveillé, l. c., 145 (1914); l. c. 35 (1914). — **Synon. nov.**

CHINA. K w e i c h o u : environs de Gan-pin, dans les rocailles, *L. Martin* in hb. Bodinier, no. 2696, Aug. 2, 1897, "petit arbuste, fl. blanches" (syntype of *Aralia Bodinieri;* photo. in A. A.); same locality and same collector, no. 2696 in part, Aug. 27, 1899 (syntype of *Aralia Bodinieri,* ex Léveillé); Pin-fa, *J. Cavalerie,* no. 871, Feb. 17, 1905, "fruit noir" (holotype of *Heptapleurum Esquirolii,* photo. in A. A.).

Aralia chinensis L. var. **nuda** Nakai in Jour. Arnold Arb. v. 32 (1924).

Eleutherococcus Mairei Léveillé in Fedde, Rep. Spec. Nov. XIII. 342 (1914); Cat. Pl. Yun-Nan, 11 (1915). — **Synon. nov.**

CHINA. Y u n n a n : brousse des montagnes à Pe-long-tsin, alt. 3200 m., *E. E. Maire,* Nov. 1913, "petit arbre moelleux, haut 3-4 m., feuilles pennées, en panache au sommet" (holotype of *Eleutherococcus Mairei;* merotype in A. A.).

Maire's specimen consists only of an inflorescence with flowers and immature fruits, about 35 cm. long and 11 cm. wide; it agrees exactly with *A. chinensis* and the rather slight pubescence indicates var. *nuda.*

CORNACEAE

Cornus oblonga Wallich in Roxburgh, Fl. Ind. I. 432 (1920). — Léveillé, Cat. Pl. Yun-Nan, 59 (1916).

Ardisia discolor Léveillé in Fedde, Rep. Spec. Nov. x. 373 (1912); Fl. Kouy-Tchéou, 283 (1915). — **Synon. nov.**

CHINA. K w e i c h o u : Ma-jo, *J. Cavalerie,* no. 3610 (holotype of *Ardisia discolor;* merotype in A. A.).

Cornus Monbeigii Hemsley in Kew Bull. Misc. Inform. 1909, p. 333, "Mombeigii."

Cornus rosea Léveillé in Bull. Géog. Bot. XXIV. 288 (1914); Cat. Pl. Yun-Nan, 59 (1916). — **Synon. nov.**

CHINA. Y u n n a n : paturages du plateau de Je-ma-tchouan, 3200 m., *E. E. Maire,* July 1912 (holotype of *C. rosea;* merotype in A. A.).

Cornus macrophylla Wallich in Roxburgh, Fl. Ind. I. 433 (1820); — Léveillé, Fl. Kouy-Tchéou, 116 (1914); Cat. Pl. Yun-Nan, 59 (1916).

Cornus Bodinieri Léveillé, Fl. Kouy-Tchéou, 116 (1914), pro synon. *C. macrophyllae.*

China. Kweichou: environs de Kouy-yang, bois de la pagode Kien-lin-chan, *E. Bodinier,* no. 1587 in part, April 14, 1898 (holotype of *C. Bodinieri;* photo. in A. A.); près du College, a Lantsong, *E. Bodinier,* no. 1587 in part, May 7, 1897.

The name *Cornus Bodinieri* is quoted only as a synonym of *C. macrophylla* (l. c.), though the labels of the two specimens cited above bear the name *Cornus Bodinieri* and not that of *C. macrophylla.* In the Flore du Kouy-Tchéou only the specimen from Kouy-yang is cited. Bodinier gives on the label of this specimen the following description of the habit of the tree and states that it is called in Chinese San chou = Arbre-parapluie: "Cet abre, qq. fois très grand, pousse d'abord un premier étage de branches partant à peu près de même point et s'étendant horizontalement comme un paraplue, plus haut, un second étage de branches, puis un troisième, puis une tête droite."

Cornus paucinervis Hance in Jour. Bot. xix. 217 (1881). — Léveillé, Fl. Kouy-Tchéou, 116 (1915); Cat. Pl. Yun-Nan, 59 (1916).

Cornus Amblardi Léveillé in Bull. Soc. Bot. France, li. cxliv. (1904); Fl. Kouy-Tchéou, 115 (1914); Cat. Pl. Yun-Nan, 59 (1916). — **Synon. nov.**

China. Kouy-Tchéou: Pin-fa, bords des ruisseaux, *J. Cavalerie,* no. 80, May 30 and July 21, 1902, "hauteur moyenne 1 m., fl. blanches" (holotype of *C. Amblardi;* photo. in A. A.); Kouy-yang, mont du Collège, à la Cascade, *E. Bodinier,* no. 2317, May 28, 1898, "arbuste, belles fleurs blanches" (cited in Fl. Kouy-Tchéou under *C. Amblardi;* duplicate in A. A.).

Cornus canadensis Linnaeus, Spec. Pl. 118 (1753).

Cornus Fauriei Léveillé in Fedde, Rep. Spec. Nov. viii. 281 (1910). — **Synon. nov.**

Saghalin: in silvis Soriofka, *U. Faurie,* no. 762, Sept. 2, 1908 (holotype of *C. Fauriei;* photo. in A. A.).

Cornus capitata Wall. var. **mollis** Rehder in Sargent, Pl. Wilson. ii. 579 (1916, March).

?Cornus capitata var. *hypoleuca* Léveillé, Cat. Pl. Yun-Nan, 59 (1916, May).

China. Yunnan: mi-mont du Io-chan, 3300 m., *E. E. Maire,* June 1912 (holotype of *C. capitata* var. *hypoleuca;* ex Léveillé).

I have not seen the type of *C. capitata* var. *hypoleuca,* but according to Léveillé's description it is probably the same as my *C. capitata* var. *mollis* which was based on Hupeh specimens.

(To be continued)

Herbarium Arnold Arboretum,
Harvard University.

STUDIES IN THE GENUS FRAXINUS

I. A PRELIMINARY KEY TO WINTER TWIGS FOR THE SECTIONS MELIOIDES AND BUMELIOIDES.

C. M. WHELDEN

With plates 87-89 and two text figures

THIS STUDY represents a preliminary attempt to provide a key for the identification of certain species of *Fraxinus* in the winter condition. The key is a preliminary one in two respects. In the first place, it is limited to those species of the sections Melioides and Bumelioides of which living material was available for study. In the second place, like any key based entirely on dormant twigs, it needs extensive checking in the field. For this reason, the author will be grateful if those who use the key and the descriptions will bring any inaccuracies to his attention.

Wherever possible collections were made at several localities, and from many trees. In the case of exotic species grown only at the Arnold Arboretum, it was often necessary to limit the study to one or two trees, supplementing the information thus gathered with such evidence as could be obtained from herbarium material.

The following species and varieties were included in the study. The numbers in parenthesis refer to the number of localities at which collections were made, exclusive of herbarium material.

SECTION MELIOIDES

Fraxinus pennsylvanica Marsh. (3).
" biltmoreana Beadle (2).
" profunda Bush (2).
" oregona Nutt. (1).
" pennsylvanica var. lanceolata Sarg. (3).
" americana L. (7).
" texensis Sarg. (1).

SECTION BUMELIOIDES

Fraxinus syriaca Boiss. (1).
" potamophila Herd. (1).
" quadrangulata Michx. (3).
" mandshurica Rupr. (1).
" holotricha Koehne (1).
" oxycarpa Willd. (1).
" excelsior L. (1).
" nigra Marsh. (4).

A twig of *Fraxinus* in the winter condition (Fig. 1) presents a number of features of diagnostic value: terminal bud, terminal bud scales, terminal bud scale scars, lateral buds, leaf scars, bundle scars, lenticels, bark, pubescence.

TERMINAL BUD: The terminal bud varies in shape from obtuse as in *F. americana* to acute as in *F. biltmoreana*. The terminal bud is of a brown color which ranges from nearly black in *F. excelsior* to a light rusty brown in *F. pennsylvanica*. In all cases, except that of *F. nigra*, the terminal bud is closely flanked by a pair of lateral buds. In *F. nigra* the terminal bud is solitary, that is, it is raised above the distal pair of laterals.

1

2

FIGURE 1. Dormant twig of FRAXINUS (somewhat diagrammatic). 1, terminal bud; 2, lenticels; 3, lateral bud; 4, leaf scar; 5, bundle scars; 6, terminal bud scale scars.

FIGURE 2. Cross section of a terminal bud of FRAXINUS. Bud scales are shaded with diagonal lines, leaves are cross hatched.

TERMINAL BUD SCALES: The number of terminal bud scales varies from two to four pairs, although it is generally consistent within a given species. The scales are arranged decussately as shown in Fig. 2. The individual scales vary in shape from ovate, apiculate, flat, to lanceolate, pinnate, and thickened on the back. They also may be tightly appressed (*F. americana*) or loose (*F. mandshurica*). A character of considerable systematic importance is the development of the foliar tip of the terminal bud scales. Though it is subject to considerable variation within the species, it remains as one of the best

guides to winter identification. The terminal bud scales are always pubescent, varying somewhat in degree. In *F. quadrangulata,* they are hoary tomentose, while at the other extreme are such species as *F. americana* and *F. texensis* in which the pubescence is reduced to a minute scurfy puberulence. The inner scales of *F. syriaca* are hoary tomentose and protrude from beneath the outer scales. The outer scales of *F. biltmoreana* are wooly along their midrib.

TERMINAL BUD SCALE SCARS: The number of terminal bud scales can be more readily obtained from the scars than from the bud itself. This number is a valuable aid in the identification of the species. For example, *F. americana* has four pairs; *F. nigra* and *F. quadrangulata* have three pairs; while *F. oxycarpa* has two pairs.

LATERAL BUDS: The number of leaf pairs per year varies from three or even two pairs to as high as twelve pairs. Ordinarily they are arranged oppositely except in *F. syriaca* where they are usually whorled. The whorled arrangement may occur in any of the species. It was found occasionally in *F. potamophila* and *F. oxycarpa,* and in a single specimen of *F. americana.*

The lateral buds of *Fraxinus* may be divergent or convergent; angular or rounded. Divergent buds are those which stand at a sharp angle to the twig rather than being closely pressed and nearly parallel with it. Angular buds are those which tend to be diamond shaped rather than circular in cross section.

LEAF SCARS: The leaf scars range from semiorbicular or crescent shaped (*F. americana*) to semicircular (*F. pennsylvanica*) to oblong or obconic (*F. profunda*) to orbicular (*F. nigra*) to obcordate (*F. biltmoreana*). The leaf scars may be raised from the surface of the twig as in *F. mandshurica* or flat as in *F. pennsylvanica.*

The upper edge of the leaf scar protrudes, forming a shelf which sheathes in varying degree the base of its lateral bud in the following species; *F. oxycarpa, F. nigra, F. pennsylvanica, F. pennsylvanica var. lanceolata, F. excelsior, F. oregona, F. profunda, F. quadrangulata, F. mandshurica, F. holotricha, F. biltmoreana* and *F. texensis.* This feature reaches its maximum development in *F. nigra.* Pubescence appears on the extreme upper edge of this shelf in the following species; *F. pennsylvanica var. lanceolata, F. biltmoreana, F. holotricha* and *F. mandshurica.* Generally the surface of the scar is flat, but the conspicuous shelf in *F. nigra* gives it a concave appearance while the raised bundle scars of *F. profunda* make the scar appear convex.

The leaf scars of *F. pennsylvanica* and *F. oregona* are often a darker color below the bundle scars than above them. That is, the lower portion may be greenish grey (*F. oregona*) or dull brick-red (*F.*

pennsylvanica). The upper part of the scar is always a dull light buff.

The angle which the leaf scar makes with the twig is from 45° (*F. americana*) to nearly parallel with the twig surface (*F. nigra*).

BUNDLE SCARS: The bundle scars of *Fraxinus* are confluent, forming a slightly raised line above the surface of the leaf scar. This is often very pronounced in *F. profunda*. The line parallels the margin of the leaf scar, even turning in at its upper edge. The relative position of the line varies, that is, it is nearer the margin than the center of the leaf scar in *F. americana* while in *F. quadrangulata* this condition is reversed. Due to the confluence of the bundle scars it is difficult to ascertain their number which seems to vary from twenty to thirty in each leaf scar.

LENTICELS: In all the species of *Fraxinus* examined, the lenticels are conspicuous, more or less elongated, light colored dots. They are scattered over the twig except in *F. quadrangulata* where often they tend to be grouped beneath the leaf scar.

BARK: The outer bark of the twigs is of little diagnostic value. The bark of *F. oregona* has a greenish hue beneath the pubescence, whereas that of *F. americana* is dark shiny maroon often splotched with a glaucus bloom.

The inner bark in the Melioides section is shiny brick-red while that of the Bumelioides section is dull light buff except in the case of *F. oregona* which resembles the Melioides section. The internodes of *F. quadrangulata* are more or less four-angled due to the development of corky ridges.

PUBESCENCE: The degree of pubescence varies from completely glabrous (*F. americana*) to tomentose (*F. biltmoreana*). The pubescence of *F. pennsylvanica* may persist for two or three seasons or disappear after the first summer, while that of *F. biltmoreana* usually does not persist after the first summer.

The pubescence of *F. quadrangulata* and *F. oregona* is more dense at the nodes than at any other part of the twig. The twig of *F. nigra* is glabrous except just below the terminal bud where there are many small dots of scurfy-pubescence.

KEY TO SECTIONS

A. Terminal bud scales entire; inner bark brick-red (except in *F. oregona*) ..... MELIOIDES

AA. Terminal bud scales foliar; inner bark light buff.... BUMELIOIDES

Section MELIOIDES

A. Branchlets pubescent.

B. Twigs tomentose throughout; buds light brown.

C. Diameter of terminal bud conspicuously smaller than that of twig; upper edge of leaf scars not lined with hairs. .....1. *F. pennsylvanica*

CC. Diameter of terminal bud equal to or larger than that of twig; upper edge of leaf scars lined with hairs .....2. *F. biltmoreana*

BB. Twigs unevenly tomentose; buds dark brown.

C. Terminal bud scales usually in three pairs; outer terminal bud scales usually sharply truncate. 3. *F. profunda*

CC. Terminal bud scales usually in four pairs; outer terminal bud scales not truncate. .....4. *F. oregona*

AA. Branchlets glabrous.

B. Terminal bud acute. ....5. *F. pennsylvanica var. lanceolata*

BB. Terminal bud obtuse.

C. Terminal bud scales usually in four pairs; base of lateral buds not sheathed. .....6. *F. americana*

CC. Terminal bud scales usually in three pairs; base of lateral buds sheathed. .....7. *F. texensis*

Section BUMELIOIDES

A. Twigs shiny green; lateral buds keeled, not sheathed at base.

B. Inner lateral bud scales visible, light wooly pubescent; upper edge of leaf scars protruding; bundle scars above center of leaf scar; leaves always whorled. .....8. *F. syriaca*

BB. Inner lateral bud scales not visible; upper edge of leaf scars not protruding; bundle scars bisecting leaf scar; leaves seldom whorled. .....9. *F. potamophila*

AA. Twigs not shiny green; lateral buds not keeled, sheathed at base.

B. Twigs with more or less quadrangular internodes.

C. Lenticels often grouped below leaf scars; lower edge of leafs scars often flattened; twigs short rufous to scurfy-pubescent; buds wooly-pubescent. 10. *F. quadrangulata*

CC. Lenticels scattered; lower edge of leaf scars rounded: twigs glabrous; buds scurfy-pubescent. 11. *F. mandshurica*

BB. Twigs with rounded internodes.

C. Twigs pubescent; terminal bud scales usually in three pairs. .....12. *F. holotricha*

CC. Twigs glabrous; terminal bud scales usually in two or three pairs.

D. Terminal bud scales in two pairs; twigs flattened at nodes .....13. *F. oxycarpa*

DD. Terminal bud scales usually in three pairs; twigs rounded at nodes.

E. Terminal bud flanked, obtuse; upper edge of leaf scars protruding slightly. .....14. *F. excelsior*

EE. Terminal bud solitary, acute; upper edge of leaf scars protruding sharply. .....15. *F. nigra*

DESCRIPTION OF SPECIES

1. **Fraxinus pennsylvanica** Marsh. Plate 87, Fig. 1.

Terminal bud acute, flanked or nearly so; three pairs of scales, outer pair truncate, rufous-tomentose, usually rusty-brown. Lateral buds rounded. Leaf scars semicircular, parallel with twig or nearly so, upper edge protruding slightly. Twigs stout, tomentose, pubescence often persisting through third season. Portion of leaf scar below bundle scars sometimes dull red. Bark of twig immediately below leaf scar often brick-red. Inner bark shiny brick-red.

2. **Fraxinus biltmoreana** Beadle. Plate 87, Fig. 2.

Terminal bud apiculate, usually broader than long, flanked; three pairs of keeled scales, villose, light rusty-brown to dark brown, outer pair shorter than inner and often truncate. Lateral buds rounded, scurfy-pubescent. Leaf scars obcordate to semicircular, at thirty to forty-five degree angle with twig, upper edge hirsute, protruding slightly. Twigs stout, tomentose. Inner bark shiny brick-red.

3. **Fraxinus profunda** Bush. Plate 87, Fig. 3.

Terminal bud obtuse, ovoid, always flanked; three pairs of scales covered with heavy scurfy pubescence, dark brown, outer pair slightly longer than inner and often truncate to form apical notch. Lateral buds small, rounded. Leaf scars oblong, obconic, at ten to thirty degree angle with twig, upper edge protruding slightly, surface of scar often ridged due to raised bundle scars. Twigs stout, sparsely tomentose, pubescence usually not persisting after the first year. Inner bark shiny brick-red.

4. **Fraxinus oregona** Nutt. Plate 87, Fig. 4.

Terminal bud obtuse, apiculate, about as broad as long, always flanked; four pairs of scales, outer pair as long as inner, scurfy-pubescent. Lateral buds rounded, scurfy-pubescent. Leaf scars semi-orbicular to crescent-shaped, at forty-five degree angle with twig, upper edge wavy, protruding slightly. Twigs stout, unevenly tomentose. Pubescence heaviest at the node. Bark of twig greyish green beneath pubescence. Inner bark brick-red to light buff.

5. **Fraxinus pennsylvanica** var. **lanceolata** Sarg. Plate 87, Fig. 5.

Terminal bud acute, always flanked; three pairs of scales, outer pair sometimes truncate, rufous-tomentose, brown to black. Lateral buds rounded or angular. Leaf scars semicircular, usually nearly parallel with twig, upper edge protruding. Twigs stout, ashy grey. Bark of twig below leaf scars sometimes brick-red. Inner bark shiny brick-red.

6. **Fraxinus americana** L. Plate 87, Figs. 6 & 7.

Terminal bud obtuse, ovoid, always flanked; three to four pairs of scales, scurfy-puberulous, brown to nearly black, broader than long, outer pair of scales shorter than inner pairs. Lateral buds rounded, often superposed on vigorous shoots. Leaf scars semiorbicular or crescent-shaped at forty-five degree angle with twig. Twigs stout, glabrous, often splotched with glaucous bloom. Inner bark shiny brick-red.

7. **Fraxinus texensis** Sarg. Plate 87, Fig. 8.

Terminal bud obtuse, ovoid, always flanked; three pairs of scales, minutely puberulous, light rusty-brown to dark brown, broader than long, outer pair shorter than inner and often truncated. Lateral buds flattened. Leaf scars semiorbicular to crescent-shaped, at forty-five degree angle with twig, upper edge protruding slightly. Twigs moderately stout, glabrous, often splotched with bloom. Inner bark shiny brick-red.

8. **Fraxinus syriaca** Boiss. Plate 88, Fig. 9.

Terminal bud acute, flanked or nearly so; scales whorled, those of outer whorl foliar and thickened on back, dark brown, slightly puberulous, hairy at tip. Lateral buds rounded. Leaf scars semiorbicular, whorled, small, dark colored, upper edge not protruding, at forty-five degree angle with twig, elevated. Twigs stout, glabrous, shiny green. Inner bark light buff.

9. **Fraxinus potamophila** Herd. Plate 88, Fig. 10.

Terminal bud acute, always flanked; outer scales with foliar tip, thickened on back, slightly puberulous, dark brown. Lateral buds small, rounded to angular. Leaf scars semicircular, small, dark colored, at forty-five degree angle with twig, elevated, upper edge not protruding. Twigs stout, dark grey-brown and glabrous. Bark often light tan around rim of leaf scars. Inner bark life buff.

10. **Fraxinus quadrangulata** Michx. Plate 88, Fig. 11.

Terminal bud acute, always flanked; three pairs of scales, outer pair longer than inner, keeled on back, tip of outer pair usually decidedly foliar, hoary-tomentose pubescence, light buff. Lateral buds rounded to somewhat flattened. Leaf scars semiorbicular to crescent-shaped, more or less flattened on lower edge, at forty-five degree angle with twig, upper edge protruding very slightly. Twigs stout, more or less four-angled between the node. Pubescence short, rufous, heaviest at the nodes. Inner bark light buff. Lenticels often grouped beneath the leaf scars.

11. **Fraxinus mandshurica** Rupr. Plate 88, Fig. 12.

Terminal bud acute, always flanked; three pairs of scales, outer pair usually foliar, second pair occasionally so, dark brown, minutely puberulous, lateral buds angular, divergent. Leaf scars crescent-shaped, at forty-five degree angle with twig, elevated, upper edge hairy, protruding. Twigs often slender, flattened at nodes causing twig to have somewhat quadrangular internodes, glabrous. Inner bark light buff.

12. **Fraxinus holotricha** Koehne. Plate 88, Fig. 13.

Terminal bud acute, always flanked, usually at 90 degree angle with twig; three pairs of scales, outer pair with foliar tips, first and second pairs decidedly thickened on back and wooly along the side, dark brown. Lateral buds angular. Leaf scars semicircular, at ten degree angle with twig, upper edge protruding and hairy. Twigs slender, villous-tomentose. Inner bark light buff.

13. **Fraxinus oxycarpa** Willd. Plate 88, Fig. 14.

Terminal bud acute, always flanked; usually two pairs of scales, the outer pair foliar and longer than inner pairs, thickened on back, dark brown, slightly puberulous. Lateral buds small, rounded to somewhat angular. Leaf scars semicircular, thirty degree angle with twig, slightly elevated, upper edge protruding. Twigs often slender, flattened at nodes, glabrous. Inner bark light buff.

14. **Fraxinus excelsior** L. Plate 88, Fig. 15

Terminal bud obtuse, ovoid, always flanked; three pairs of scales, the outer pair about as long as the inner and having a more or less foliar tip, slightly puberulous, nearly black. Lateral buds rounded, sometimes with scattered, silky pubescence on the outer side. Leaf scars semicircular to semiorbicular, elevated, upper edge noticeably protruding. Twigs, stout, glabrous. Inner bark light buff.

15. **Fraxinus nigra** Marsh. Plate 88, Fig. 16.

Terminal bud acute, always solitary; three pairs of scales, the outer pair more or less foliar at the tip, thickened on back, dark brown, puberulous. Lateral buds small. Leaf scars orbicular, concave when viewed from the side due to the protruding upper edge, from nearly parallel to ten degree angle with twig. Bundle scars conspicuous. Twigs stout, glabrous except for small dots of scurfy pubescence just below the terminal bud. Inner bark light buff.

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EXPLANATION OF THE PLATES.

Plates 87 and 88

Terminal and lateral buds of Fraxinus (× 3). Taken with a micro-tessar lens under approximately equal magnification and illumination.

Plate 87. Species of § Melioides: 1, *F. pennsylvanica;* 2, *F. biltmoreana;* 3, *F. profunda;* 4, *F. oregona;* 5, *F. pennsylvanica* var. *lanceolata;* 6, *F. americana* (whorled); 7, *F. americana;* 8, *F. texensis.*

Plate 88. Species of § Bumelioides: 9, *F. syriaca;* 10, *F. potamophila;* 11, *F. quadrangulata;* 12, *F. mandshurica;* 13, *F. holotricha;* 14, *F. oxycarpa;* 15, *F. excelsior;* 16, *F. nigra.*

Plate 89

Variation in Fraxinus twigs. Collections of the same species from various points.

Nos. 1 to 5, *F. americana;* 1, St. Louis, Missouri; 2, Indiana; 3, Granville, Mass.; 4, Norwich, Vt.; 5, Arnold Arboretum.

Nos. 6 to 8, *F. pennsylvanica* var. *lanceolata;* 6, Indiana; 7, Indiana; 8, Arnold Arboretum.

Nos. 9 & 10, *F. profunda;* 9, Arnold Arboretum; 10, Indiana.

Nos. 11 & 12, *F. quadrangulata;* 11, St. Louis, Missouri; 12, Indiana.

Nos. 13 & 14, *F. pennsylvanica;* 13, Dedham, Mass.; 14, Newton, Mass.

Nos. 15 & 16, *F. nigra;* 15, Petersham, Mass.; 16, Hanover, N. H.

ARNOLD ARBORETUM, HARVARD UNIVERSITY, AND
HARVARD FOREST, PETERSHAM, MASS.

Studies in the Genus Fraxinus

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NOTES ON SOME PLANTS OF OKLAHOMA

Ernest J. Palmer

In July, 1933, I spent about a week collecting in Oklahoma, entering the state near the northwest corner, approximately on the 101st meridian. Traveling in a south and east direction we crossed the North Canadian River at Beaver, and mainly followed the course of that stream to Woodward. From that point a side trip was made to Grand, in Ellis County, before turning south to the Wichita Mountains, east to the Arbuckle Mountains, and south and east to Hugo, where we crossed Red River into Texas.

In this very hasty dip into the flora of the state, some parts of the trip being in localities I had not visited before, a number of interesting plants were found, some of which have not, so far as I know, been previously reported from Oklahoma.

In the northwest part of the state we were in a typical plains country, with very few native woody plants. The weather was extremely dry, practically no rain having fallen for several months according to reports, and as a visible result trees planted about the primitive farm and ranch houses were dead or dying in many places, and few herbaceous plants were in evidence except along ravines and the borders of streams. Cottonwood trees, the black and sand-bar willow, and the willow-leaved groundsel (*Baccharis salicina*) are common along most small streams, and a few other species begin to appear along the rivers, especially where the country is sandy, as is the case in the vicinity of Beaver. Stopping along a little spring-fed tributary of the North Canadian a mile or two north of that town we were in the edge of the sand hills and dunes with a characteristic flora. The only arborescent species on the dry hills was the hackberry (*Celtis reticulata* var. *vestita*), and these trees were of small size. *Rhus trilobata* and the sand grape, *Vitis Longii,* formed large thickets, with occasional clumps of small plum bushes (*Prunus angustifolia*); *Berula erecta, Samolus parviflorus, Juncus Torreyi, Euphorbia petiolata* and *Asclepias incarnata* were growing along the immediate margins or banks of the little stream, and farther back in the sand dunes we collected *Stillingia sylvatica, Oreocarya suffruticosa, Palafoxia Hookeriana* and *Berlandiera texana.*

Near Laverne, in Harper County, a short stop was made to collect along the gravelly shallow bed of a creek, now entirely dry. *Eustoma*

Russellianum was growing here. This plant of the Gentian family, with its large deep purple flowers and glaucous foliage, is one of the handsomest wild flowers of the plains. Here also we found *Indigofera leptophylla, Cristatella Jamesii, Heliotropium convolvulaceum, Eriogonum annuum, Solidago glaberrima* and several other species which were managing to flower in spite of the drought.

North of Dunlap the dunes are extensively developed. The sage brush covers large areas, and thickets of *Prunus angustifolia* are numerous in slight depressions. Occasional clumps of *Yucca glauca* and of the tall grass, *Calamagrostis gigantea,* stood out conspicuously, and a tall crucifer, *Dithyrea Wislizenii* with its white flowers and curious seed pods, somewhat like a pair of spectacles or a figure eight in outline, was abundant in places.

At Woodward we visited the Northern Great Plains Experiment Station, of the U. S. Department of Agriculture, and were surprised to see the number of native and exotic trees and shrubs that are being grown here, testing their adaptability to the very trying conditions of this part of the country with its comparatively cold winters, hot summers and frequent long periods of drought, which in combination with the variety of soils and other factors makes a most complex problem for the pursuit of agriculture and horticulture even in the subordinate rôle that it plays and seems destined to play in a country more adapted to stock raising and grazing.

We were particularly interested, however, in the native flora, and after having been shown over the station, in the absence of the Director, Mr. E. F. Chilcott, we were guided on a collecting trip by Mr. L. F. Locke and two other members of the staff.

The flora in the vicinity of Woodward is distinctly more varied and abundant than that through which we had been passing farther west in the "Panhandle" counties, and it begins to take on more of the aspect of the southern plains, with but slight resemblance to that of the Mississippi valley and the Middle States. Looking over the landscape from a point of vantage the most striking botanical feature is the shrubby oaks, growing in thickets or "mottes" of varying size from two or three meters to twenty meters or more in diameter. The formation is dense; the largest shrubs near the center are sometimes two or three meters high, decreasing gradually in size towards the margins. There are two varieties of the post oak, *Quercus stellata* var. *rufescens* Sarg. and *Q. stellata* var. *parviloba* Sarg., and with them a more slender species of quite different habit, *Quercus Havardi* Rydb. This species usually grows with single or only a few stems, a meter or a

meter and a half in height, which are often weighed down to the ground with the large crop of heavy acorns. The post oaks apparently propagate both by stolons and seedlings, but probably more commonly by the latter method, as they produce large crops of acorns in most seasons and these germinate readily in the sandy soil in seasons where there is a normal amount of rainfall. Thickets of both *Prunus angustifolia* and *P. gracilis* are frequent as well as *Yucca glauca* which is conspicuous on the dryer slopes and summits of the sand hills. Thickets begin to appear along the smaller streams, in which *Celtis reticulata* var. *vestita, Rhus glabra, Ptelea trifoliata, Celastrus scandens, Ampelopsis cordata, Sapindus Drummondii* and *Bumelia lanuginosa* were noted.

Going southward into Ellis County we passed through miles of this type of flora with the mottes of scrub oak scattered over the sand hills stretching as far as could be seen. At the old town of Grand, once an important trading center for this part of the country, but now reduced to a single general store and two or three houses, we came to the main or southern branch of the Canadian River. The country bordering the river at this point is hilly and deeply eroded with ravines and gullies leading down to the alluvial valley. Some of these ravines or small cañons furnish protection to trees and other plants that cannot grow on the plains and that are found nowhere else in this part of the country. One of the most interesting trees of the cañons is *Juglans major* (Torr.) Heller[1], the largest specimens of which were 7 or 8 meters high. Some of the trees were in fruit and old fruit was found under others. There is much variation in the size and shape of the nuts of this species here as in other parts of its range, and the reports of *Juglans rupestris* Engelm. from Oklahoma are probably based upon small-fruited forms of this. At least, I have not seen the latter species in Oklahoma and its range probably does not extend as far north. These trees had been discovered and kept under observation by the botanists of the Experiment Station and seedlings of several of them are in cultivation there. Amongst other woody plants growing in the protection of the cañons were *Juniperus virginiana, Celtis laevigata* var. *texana, Morus rubra* and *Parthenocissus vitacea.* On dry gypseous banks a large-flowered evening-primrose, *Megapterium oklahomense* was in bloom, and a little farther up on open ground was found a shrubby cat's-claw, *Mimosa borealis.* On the hills the soil is gravelly and much eroded, with small masses of sandstone and chert and occa-

[1]Since I have returned to the Arboretum Mr. Lock has sent me specimens of *Juglans major* collected along the North Canadian River, northeast of Woodward, which extends the range of the species considerably farther north than it had previously been known.

sional fragments of silicified wood. *Ceanothus ovatus* var. *pubescens*, *Scutellaria resinosa* and *Houstonia angustifolia* are found along dry banks and ledges, and several sorts of cacti of the genera *Opuntia*, *Neomamillaria* and *Echinocereus* grow on the dry level areas. In the broader open spaces and along the foot of the hills, mesquite trees (*Prosopis juliflora*) are growing and *Ptelea polyadenia* was also collected here.

On leaving Woodward the next day we stopped for a few minutes just south of the little town of Sharon at the crossing of North Persimmon Creek. Here a few more eastern plants begin to put in an appearance. Amongst those seen along the creek were *Quercus macrocarpa*, *Q. Muhlenbergii*, *Morus rubra*, *Ribes odoratum*, *Rubus flagellaris*, *Cornus asperifolia* and *Cocculus carolinus*.

Proceeding south we arrived sometime in the afternoon at Hobart on the edge of the Wichita Mountains. This group consists of a series of knobs and ridges of granite and other igneous rocks, which, due to their greater resistance have been preserved as the softer sedimentary strata into which they were originally intruded, have been removed by erosion. Some of the domes stand out impressively on the sky-line, but they are seldom more than a few hundred feet above the surrounding plain.

Our first stop was made near the village of Lone Wolf, where we climbed some of the low foot-hills. *Juglans major* is rather frequent here growing in the protection of ledges and clefts, and the shrubby honeysuckle of the Southwest, *Lonicera albiflora* was also collected. Two southwestern ferns, *Cheilanthes Eatoni* and *Notholaena Hookeri* were growing in rubble and clefts of the granite, but most of the fronds were too much withered to be collected.

As there were no camping facilities here and it was getting late, we turned back east to Coopertown, just beyond which we entered the Wichita National Forest and stopped for the night at a camping place along a little mountain stream, now quite dry. The following morning Mr. Edward King, my traveling companion, and I set out to explore the surrounding region.

The forest is in most places very sparse, most of the woody species being confined to the vicinity of small streams and ravines or to the bases of the more precipitous hills. A few small trees and shrubs are found higher up on the hills or on their summits wherever there is a little irregularity of surface to afford some protection. There are wide open spaces between the hills with a grassy and herbaceous flora and sometimes with a few mesquite trees. Even along the mountain streams

and in the little valleys where the trees reach their largest size, there is little that can be called real forest. Post oak, black oak, mulberry, and hackberry are amongst the commonest tree, with cottonwood (*Populus balsamifera*), Ward's willow (*Salix longipes* var. *Wardii*), walnut (*Juglans major*), cat-briar (*Smilax Bona-nox*) and buttonbush growing along the immediate margins of the creeks. The big-tree plum (*Prunus mexicana*) and the false grape (*Ampelopsis cordata*) were also collected here. The red cedar (*Juniperus virginiana*) and black jack oak (*Quercus marilandica*) are sometimes found on the higher slopes or tops of the mountains, and the lead plant (*Amorpha canescens*) on dry rocky slopes. *Acacia angustissima* and a curious woody vine with fleshy leaves (*Cissus incisa*) were growing in clefts of the rock. A species of wafer ash, which appears to be *Ptelea aboriginum* Greene, was collected on a rocky open slope, and in a little cove a little higher up I found *Rubus oklahomus,* a species of blackberry recently described by Dr. Bailey, and near by was a large sized tree of *Crataegus Stevensiana* Sarg., which was the only species of this large group seen in the forest.

On a north slope, below a small granite bluff, a small thicket of the western choke cherry (*Prunus virginiana* var. *demissa*) was growing and in clefts of the bluff we collected the marginal shield fern (*Thelypteris marginalis*) and *Arenaria stricta* var. *texana.* Before returning to the camp we crossed an open valley to another granite ridge with a rather heavy growth of woods along the base. In the rubble and large detached masses of rock here we found the little Rocky Mountain maple (*Acer grandidentatum*). As it grows here, it is a stout shrub not more than two or two and a half meters in height, with branches scarcely extended above the height of the rocky walls in the protection of which it was growing. This is the most eastern known limit for this western species and its presence here is particularly interesting as indicating a former invasion of Rocky Mountain plants into the region. Another shrubby plant that attracted our attention from its showy appearance was a form of *Cephalanthus occidentalis* growing in springy ground along a little creek, and covered with fruit of a bright red color. This might very well be used as an ornamental plant if the color of the fruit could be retained in cultivation.

Herbaceous plants were not much in evidence at this dry season. Amongst the most conspicuous were *Eriogonum longifolium, Grindelia nuda, Gaillardia pulchella* and *Thelesperma ambiguum,* which were still flowering. I also collected *Portulaca lanceolata* in decomposed granite near Lone Wolf, *Aristida Wrightii,* which is one of the commonest

grasses, *Houstonia angustifolia, Scutellaria resinosa* and *Commelina erecta* in rocky open ground, and *Cyperus Schweinitzii* and *Sabbatia campestris* in moist ground along a little brook.

After having lunch we loaded the car and set out eastward towards Paradise Springs where we planned to stop for the night. Several stops were made to take photographs of the hills and of some of the plants, and to collect plants along a branch of Cache Creek. This was a rather larger stream than those we had been on before and additional species began to appear. The chinquapin oak (*Quercus Muhlenbergii*) and the red and green ash (*Fraxinus pennsylvanica* and *F. pennsylvanica* var. *lanceolata*) were growing along the creek bank. We crossed this stream or another branch of it again near the Forest Headquarters, and here we added the pecan (*Carya pecan*), Schneck's oak (*Quercus Shumardii* var. *Schneckii*) and the little sand grape (*Vitis rupestris*) to our list. The grape vine was growing in the shingle and gravel of the creek bed and trailing over the larger rocks, which is a characteristic habitat for this species. Only one tree of Schneck's oak was seen on the creek bank here, but it becomes commoner a little farther south and west, where I have collected it near the village of Cache.

The following day, without having made other stops, we arrived at the Arbuckle Mountains, stopping first to have lunch at Turner Falls State Park, which has been made a popular resort. Here we were in a region of striking contrast in many respects to the Wichita Mountains. If the Wichita Mountains are such only by courtesy, it might be thought to put a strong tax upon the proprieties or at least upon scientific accuracy to designate the Arbuckle region as a mountainous one. The low rounded hills are underlaid largely by a hard Paleozoic limestone, through which has been thrust a mass of porphyritic intrusive rocks that now come to the surface over a small area. The limestone is exposed on many of the hill tops and slopes and as bluffs at some places along the Washita River which traverses the region. The soil is therefore decidedly alkaline over much of the area, although it is sandy and more acid in parts of the river valley as well as where the igneous rocks are exposed. The general aspect of the country with the outcrops of hard pure limestone eroded by occasional torrential rains that interrupt the usually dry climate, give it a strong resemblance to parts of the Edwards plateau in central Texas, an impression which a study of the flora strongly confirms. The following list of plants, although necessarily a very incomplete one, resulting from collecting for only parts of two days, clearly shows this relationship, and it is scarcely

an exaggeration to say that the Arbuckle Mountains, so far as the flora is concerned, constitutes a northern extension and the farthest outpost of that interesting flora.

Cheilanthes Feei Moore
Cheilanthes tomentosa Link
Pellaea atropurpurea (L.) Link
Juniperus mexicana Spreng.
Uniola latifolia Michx.
Carya Buckleyi Durand
Carya cordiformis (Wangh.) K. Koch
Juglans major (Torr.) Heller
Quercus Muhlenbergii Engelm.
Quercus prinoides Willd.
Quercus texana Buckley
Quercus Shumardii var. Schneckii (Britt.) Sarg.
Ulmus alata Michx.
Celtis laevigata Willd.
Morus microphylla Buckley
Clematis Simsii Sweet
Ribes odoratum Wendl.
Rosa carolina L.
Rosa foliolosa Nutt.
Rubus trivialis Michx.
Crataegus bellica Sarg.
Crataegus limaria Sarg.
Crataegus viridis L.
Sophora affinis T. & G.
Cercis reniformis Engelm.
Psoralea Reverchoni Wats.
Amorpha canescens Pursh
Phyllanthus polygonoides Spreng.
Acalypha gracillima var. monococca Engelm.
Rhus copallina L.
Rhus copallina var. lanceolata Gray
Aesculus arguta Buckley
Ceanothus ovatus var. mollis T. & G.
Rhamnus caroliniana var. mollis Fern.
Ptelea nitens? Greene
Abutilon incanum Don
Sapindus Drummondii H. & A.
Vitis cordifolia Lam.
Vitis rupestris Scheele
Ampelopsis arborea (L.) Koehne
Hypericum cistifolium Lam.
Ascyron hypericoides L.
Opuntia leptocaulis DC.
Convolvulus incanus Vahl
Evolvulus argenteus Pursh
Heliotropium tenellum (Nutt.) Torr.
Verbena bipinnatifida Nutt.
Fraxinus texensis (Gray) Sarg.
Forestiera pubescens Nutt.
Satureja arkansana (Nutt.) Briq.
Lonicera albiflora T. & G.
Viburnum rufidulum Raf.
Grindelia lanceolata Nutt.
Helianthus hirsutus Raf.

Particularly significant is the occurrence here of such typically Texan species as *Juniperus mexicana, Carya Buckleyi, Quercus texana, Morus microphylla, Cercis reniformis, Psoralea Reverchoni, Rhus copallina* var. *lanceolata, Abutilon incanum, Opuntia leptocaulis* and *Fraxinus texensis*. Many of the other plants are also characteristic species of the Edwards plateau flora although of somewhat wider range. Several of the plants on the list, which have a generally more northern

and eastern range, as for example *Carya cordiformis, Rosa carolina, Rhus copallina, Vitis cordifolia* and *Ascyron hypericoides,* were not collected or noted on or near the limestone outcrops but along the river or in areas having a different type of soil.

Specimens of all of the woody plants mentioned in this paper are deposited in the herbarium of the Arnold Arboretum, and the herbaceous species may be found in the Gray Herbarium. Duplicates of most of them have been distributed to other institutions.

HERBARIUM, ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

CHROMOSOME CONSTITUTION IN CERTAIN MONOCOTYLEDONS

THOMAS W. WHITAKER

With nine text figures

MCKELVEY AND SAX (1933) have called attention to the existence of taxonomic and cytological similarities between certain genera in the Liliaceae and Amaryllidaceae. The similarity is rather striking with regard to chromosome constitution. *Yucca, Hesperoyucca, Cleistoyucca, Hesperaloë,* and *Samuela,* in the Liliaceae, all have 5 long and 25 short chromosomes. *Agave* in the Amaryllidaceae has exactly the same chromosome constitution. These observations when considered in conjunction with taxonomic resemblances, seem to indicate that the genera mentioned above are more closely related than is shown by their separation into distinct families. With the object of discovering whether this pronounced heteromorphism (5 long and 25 short chromosomes) is of general occurrence throughout the monocotyledons, a number of species have been examined.

After a casual survey, the species enumerated below were selected for further study as being the most interesting from the point of view of the problem under investigation.

1. *Polyanthes tuberosa* L. ..... Amaryllidaceae
2. *Fourcroya gigantea* Vent. ..... Amaryllidaceae
3. *Fourcroya Selloa* C. Koch ..... Amaryllidaceae
4. *Fourcroya Bedinghausii* C. Koch ..... Amaryllidaceae
5. *Doryanthes Palmeri* W. Hill ..... Amaryllidaceae
6. *Hosta coerulea* (Andrews) Tratt. ..... Liliaceae
7. *Dasylirion longissimum* Lem. ..... Liliaceae
8. *Nolina recurvata* Hemsl. ..... Liliaceae
9. *Butomus umbellatus* L. ..... Butomaceae

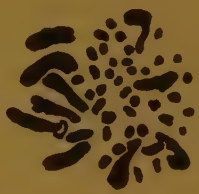
The chromosome counts were secured from root-tip material, prepared by the smear-maceration method and stained with aceto-carmine (Whitaker, 1934). In the case of *Hosta* and *Polyanthes,* the root-tip material has been augmented by counts from pollen mother cells.

Chromosome counts during meiosis indicate that *Polyanthes tuberosa* has 30 chromosomes. The chromosome constitution in this species is identical with that of the *Yucca-Agave* group. The shape and size of

the 5 long chromosomes are comparable with figures from similar stages in either *Yucca* or *Agave* (Fig. 1).

In *Fourcroya gigantea* the somatic chromosome number appears to be 60. The chromosome complement of this species consists of 10 distinctly long chromosomes and 50 short ones (Fig. 2). Counts from root-tip cells of *F. Bedinghausii* and *F. Selloa* show that these two species also have 60 somatic chromosomes. The morphology of the chromosome complement in the case of the latter two species is the same as that of *F. gigantea*.

1



2

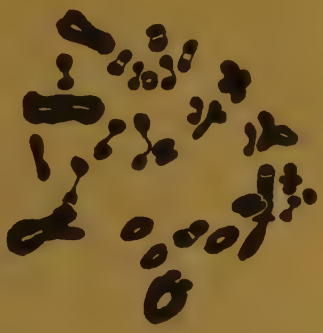
FIGURE 1. POLYANTHES TUBEROSA. 30 chromosomes at metaphase. About × 2100. — FIGURE 2. FOURCROYA GIGANTEA. 60 chromosomes at metaphase. About × 2100.

Doryanthes is the sole representative of the sub-family Agavoideae not indigenous to the desert areas of North America. The three species of this genus are all natives of Australia. *Doryanthes Palmeri*, the species from which the material was secured, has 36 somatic chromosomes (Fig. 3). On morphological grounds the chromosome complement of this species is not at all comparable with that of the North American species of the Agavoideae (compare Fig. 2 with Fig. 3). The 5 long pairs of chromosomes which are one of the conspicuous features of the chromosome set-up in *Agave, Yucca, Fourcroya,* etc. are absent in *Doryanthes Palmeri.* Long and short chromosomes are present, but there is not the same degree of difference which exists between the long and short chromosomes of the *Yucca-Agave* group. Thus there are two categories of evidence, cytological and distributional, which are opposed to the placing of *Doryanthes* in the sub-family Agavoideae.

Hosta coerulea has 30 meiotic chromosomes (Fig. 4). The chromosome constitution in this species appears to be similar to that of the *Yucca-Agave* group. There exists the possibility that one of the long chromosomes may not equal the size of the four remaining long ones. If this difference exists, it is slight, and with this exception, it is clearly apparent that the chromosome morphology of this species is

fundamentally the same as that found in *Yucca, Agave, Fourcroya,* etc. Miyake (1906) has figured the chromosomes of *Hosta Sieboldiana.* His figures show the 5 long chromosomes quite plainly, but the total number seems to be somewhat less than the 30 pairs found in *H. coerulea.* It is interesting to note that the 5 long chromosomes were also found in *H. Sieboldiana.*

3



4

FIGURE 3. DORYANTHES PALMERI. 36 chromosomes at metaphase. About × 2100. — FIGURE 4. HOSTA COERULEA. 30 chromosomes at diakinesis. About × 2500.

Dasylirion, Nolina, and *Dracaena* have been examined with the purpose of discovering a possible connecting link between these genera and the *Yucca-Agave* group. According to Johnston (quoted in McKelvey and Sax, 1933), if an affinity between the Yuccas in the Liliaceae and the Agaves in the Amaryllidaceae is to be established, it is most likely to be traced through the genera mentioned above. *Dasylirion* and *Nolina,* have distributions which closely parallel that of the *Yucca-Agave* group. Cytologically *Nolina* has nothing to contribute to the problem. *Nolina recurvata* has 36 pairs of chromosomes (Fig. 5) which are of approximately equal length. The attachment constrictions are median or sub-median in most cases.

Dasylirion longissimum seems to have 38 chromosomes, three pairs of which are very nearly twice the length of the shorter chromosomes (Fig. 6). The size difference between the long and short chromosomes of this species are not nearly as striking as the differences existing in the chromosome complement of the members of the *Yucca-Agave* group.

Dracaena arborea has about 38 chromosomes, according to McKelvey and Sax (1933). The writer has examined another species of *Dracaena* (*D. fragrans* Ker-Gawl.). This species also seems to have about 38

chromosomes, all of which are very small and very nearly of equal length.

So far as the cytological observations already completed are concerned, *Nolina*, *Dracaena*, and *Dasylirion* obviously do not point the way to further progress with the problem. *Nolina* and *Dracaena*, by reason of the morphology of their chromosome complements, can be eliminated from further consideration. *Dasylirion* has possibilities, but on the basis of its chromosome complement alone, there are not sufficient grounds for thinking of it as closely allied to the *Yucca-Agave* group.

FIGURE 5. NOLINA RECURVATA. 36 chromosomes at metaphase. About × 2500. — FIGURE 6. DASYLIRION LONGISSIMUM. 38 chromosomes at metaphase. About × 2500.

Butomus umbellatus[1] has 26 somatic chromosomes (Fig. 7). Early studies on embryo sac development, where chromosome number was reported incidentally, have led to some confusion. Holmgren (1913) has stated that the reduced number in this species is 11-12. Liehr (1916) has placed the reduced number at 8. Terby (1922), who has evidently made a very careful study of the somatic chromosomes of this species, finds 40 chromosomes. Apparently the plant or plants from which she secured her material must have been triploid in origin. In Fig. 7, where the 26 somatic chromosomes of *Butomus umbellatus* are shown at metaphase, four pairs are noticeably longer than the remainder. It is this situation which suggests that Terby's material may have been of

[1]The writer is indebted to Professor C. L. Huskins, McGill University, Montreal, Canada, for the material of *Butomus umbellatus*.

triploid nature because if another genom of 13 chromosomes were added to the diploid complement of Fig. 7, there would be twelve long chromosomes, and that is exactly what happens, as the reproduction of Terby's figure shows (Fig. 8).

FIGURE 7. BUTOMUS UMBELLATUS. 26 chromosomes at metaphase. About × 2500. — FIGURE 8. BUTOMUS UMBELLATUS (probable triploid, after Terby).

The purpose of studying the chromosome complement of this species was to indicate that the size differences among the chromosomes are of the same general order as those found in *Yucca, Fourcroya, Agave,* etc. That this is actually the case is fully substantiated by a comparison of the chromosomes of *B. umbellatus* (Fig. 7) with those of members of the *Yucca-Agave* group, *Fourcroya* for instance (Fig. 2).

DISCUSSION

Heitz (1926) mentioned the correlation existing between taxonomy and chromosome constitution in the Agavoideae. His observations on *Fourcroya,* and those of Müller (1912) on *Beschorneria* and *Agave,* led to this conclusion. He states that not only do these genera belong to the same sub-family (Agavoideae), but they are also characterized by the same sort of chromosome constitution.

McKelvey and Sax (1933), as stated previously, have pointed out the similarities with respect to chromosome constitution between the Yuccae and the Agavoideae. The chromosome set-up of representative species of these two groups is strikingly similar, and in all visible respects, identical. These investigators have stated that it is unlikely that this is due to chance but must mean that these two groups are more closely akin to each other than is indicated by the prevailing system of classification which separates them into different families.

It is clear, from this brief review of previous work, that the point to be emphasized is that a chromosome set consisting of 10 long and 50 short chromosomes is sufficiently uncommon in the plant kingdom to lead one to suspect that species having this unique chromosome constitution are of common ancestry and closely related.

The present observations on *Polyanthes* and *Fourcroya* added to those of previous investigators, give a fairly complete story in regard to chromosome constitution in the Agavoideae. Pax and Hoffmann (1930) have listed seven genera belonging to this sub-family. Disregarding *Doryanthes,* which does not seem to fit into this group, four of the remaining genera have been examined, and all have exactly the same chromosome set-up. There are some possible exceptions. Heitz (1926) has reported *Fourcroya Lindenii* as having 10-12 long and 30-39 short chromosomes, and *F. altissima* with 10 long and 40 short chromosomes. It is likely that this may be an error, for the reason that the three other species of *Fourcroya* examined all have the usual complement of 10 long and 50 short chromosomes. These observations very definitely indicate a close cytological relationship between the members of this sub-family. It is reasonable to suppose that the members of the Agavoideae are taxonomically closely allied to the Yuccae. Johnston (quoted in McKelvey and Sax, 1933) has listed a number of similarities between these two groups.

To state the essential facts in a more concise form, we have five genera in the Liliaceae (*Hesperaloë, Hesperoyucca, Cleistoyucca, Yucca, Samuela*) and four genera in the Amaryllidaceae (**Fourcroya, Agave, Beschorneria, Polyanthes*), which, on distributional, taxonomic, and cytological grounds, are closely akin to each other. These facts should be given serious consideration in any taxonomic revision of these two families where an attempt is made to arrange the genera in a phylogenetic series.

In regard to *Hosta,* the situation is difficult to interpret. There can be little doubt that it is similar in chromosome constitution to the *Yucca-Agave* group. A careful study of a number of slides has not revealed a single consistent difference by which one would be able to distinguish the chromosome complement of the two species under discussion. *Hosta,* as now constituted, is placed in the sub-family Asphodeloideae, rather widely separated from *Yucca,* which has been placed in the Dracaenoideae (Krause, 1930). Superficially, the resemblance between *Hosta* and members of the *Yucca-Agave* group are

**Prochnyanthes* and *Pseudobravoa* are genera which fit into this group on distributional and taxonomic grounds. Species of these genera were not available for cytological studies and consequently had to be omitted.

slight enough to be almost negligible. If we retain the original supposition that the possession of an identical chromosome complement is an indication of a comparatively close relationship, it must mean that it is possible to obtain a far-reaching differentiation of specific characters without a drastic change in the morphology of the chromosome complement. It is probable that chromosome constitution may behave in a manner comparable to many morphological characters, that is to say, a certain character may flow along with the main body of evidence and then suddenly diverge to a point where it is no longer of significance. Therefore, chromosome constitution as a criterion of phylogenetic relationship should only be judged in so far as it fits in with other lines of evidence.

There is some cytological evidence suggesting that the peculiar heteromorphic chromosome set-up found in the *Yucca-Agave* group may indicate a fundamental relationship which can be traced through a number of families in the monocotyledons.

The evidence for the existence of this relationship is derived from both taxonomy and cytology, and seem to point to the following conclusions:

1. There is a group of families in the Helobiae, which represent primitive generalized types.

2. It appears as if the specialized chromosome set-up of the *Yucca-Agave* group may have had its origin among the families of this order.

In the classification of Wettstein (1924), the Helobiae are considered the most primitive monocotyledenous group. In this order occur among others, such presumably primitive families at Butomaceae, Najadaceae, Hydrocharitaceae, Triuridaceae, etc. If the chromosome complement of species representing the four families mentioned above is analyzed, some rather striking similarities are apparent. There are either four or five pairs of long chromosomes associated with a varying number of short ones, no single one of which is equal to one half the length of the longer chromosomes. The attachment constriction is either median or sub-terminal in the long chromosomes and usually terminal in the short chromosomes.

In Fig. 9, the five longest chromosomes from representative species of the four families listed above have been drawn diagrammatically. The measurements have been made from metaphase plates during mitosis. The drawings have been reduced to approximately the same scale. These diagrams seem to verify the assertion that there is some measure of similarity between the five longer elements in the chromosome complement of some of the species of these four families (Butomaceae, Hydrocharitaceae, Najadaceae, Triuridaceae).

The point I wish to make, in presenting this evidence, is that the five longer elements in the chromosome complement of these four species, show some resemblance to each other; and, furthermore, they are of the same general nature as that of the five longer elements in the chromosome complement of members of the *Yucca-Agave* group. This may well be a superficial resemblance of no significance whatever, but the taxonomic and cytological evidence combine to give it a certain weight worthy of more extended investigation.

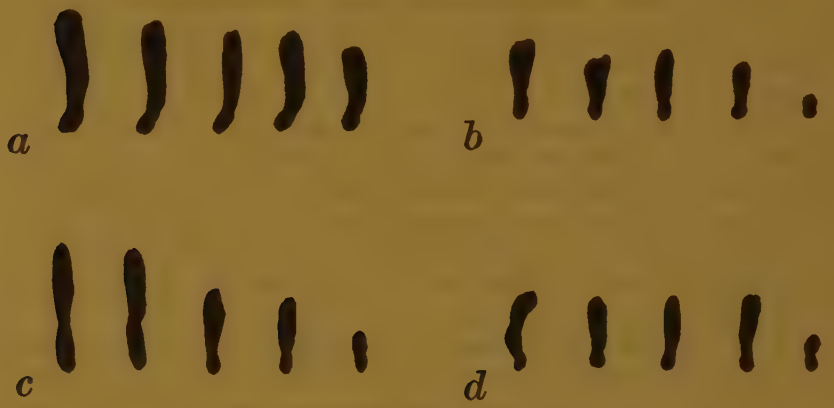


FIGURE 9. a. NAJAS MARINA L. (after Winge). — b. VALLISNERIA SPIRALIS L. (after Winge). — c. SCIAPHLIA JAPONICA Mak. (after Ohga and Sinoto). — d. BUTOMUS UMBELLATUS L.

As previously stated, Wettstein (1924) from taxonomic considerations has shown that the Helobiae are the most simple and probably the most primitive of the monocotyledons. There are very good reasons for thinking that the Liliiflorae have been derived from this group. (Janchen, 1932). It is interesting to find that the very specialized chromosome constitution of 5 long and 25 short chromosomes, characteristic of the *Yucca-Agave* group, may well have had its origin in the Helobiae.

SUMMARY

Combining the results of previous workers with those of the present investigation, it has been possible to show that five genera in the Liliaceae (*Yucca, Hesperoyucca, Hesperaloë, Cleistoyucca, Samuela*) and four genera in the Amaryllidaceae (*Agave, Fourcroya, Polyanthes, Beschorneria*) form a distinct unit and as such should be united in any future revision of these two families. The evidence for this unity is based on geographic distribution, taxonomic and cytological similarities.

There is some evidence indicating that the heteromorphic chromosome set-up found in the *Yucca-Agave* group may be of general occurrence in the monocotyledons. *Hosta* in the Liliaceae has a chromosome complement identical with this group. Several species in the Helobiae have been shown to have a chromosome set-up from which that found in the *Yucca-Agave* group may have been derived.

The writer wishes to acknowledge the helpful criticism and suggestions of Professor Karl Sax and Dr. I. M. Johnston of the Arnold Arboretum, Harvard University.

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THE OCCURRENCE OF TUMORS ON CERTAIN NICOTIANA HYBRIDS

THOMAS W. WHITAKER

With plate 90 and one text figure

INTRODUCTION

TUMORS resembling, in some measure, the outgrowths found in plants infected with the crown gall organism are produced in great abundance by certain *Nicotiana* species hybrids. These curious outgrowths were apparently first described by Kostoff (1930), who carried out a series of experiments which led him to interpret the occurrence of the tumors as a manifestation of immunological activity.

Sufficient data have been accumulated to justify a re-analysis of the situation in respect to these spontaneous tumors and to suggest a plausible explanation for their occurrence on the basis of additional evidence.

The observations reported in this paper have been confined to F_1 plants secured by crossing *Nicotiana glauca* × *N. Langsdorffii*. Without exception plants of this genetical composition produced numerous tumors in some stage of their development.

The F_1 plants of this mating were approximately intermediate in appearance between the parental species. On the whole it may be said that there was little variation among the individuals of the F_1. Chromosome counts secured from root-tip preparations indicated that the chromosome number of these plants was 21. This is the number to be expected considering that the haploid numbers of *Nicotiana glauca* and *N. Langsdorffii* are twelve and nine, respectively. The reduction division in the pollen mother cells of these plants was extremely irregular. Pairing followed the Drosera scheme. Lagging, non-disjunction and other irregularities were frequently observed. The percentage of pollen sterility was very high (96%). Numerous attempts to self-fertilize the F_1 plants resulted in complete failure. Back-crosses to both parental species, utilizing the F_1 as either male or female, have also given negative results. It was not surprising that selfing was unsuccessful in view of the high pollen sterility. Evidently some of the ovules were viable, as Kostoff (1930) obtained back-crosses to *N. Langsdorffii* by employing the F_1 as the female parent.

LOCATION OF THE TUMORS

The tumors emerge on the stem from the axillary leaf bud. Occasionally, they may emerge from the entire leaf scar area. A careful examination of a number of plants has shown that the tumors rarely, if ever, emerge from the internodal spaces of the stem. Repeated attempts to induce tumor formation by scratching and wounding the surface of the stem at locations between leaf scars have thus far failed to induce tumor formation. It has been noted on several occasions that pinching back on the terminal bud seems to stimulate tumor formation by forcing the growth into the lateral, axillary meristematic regions.

Tumors appear to be produced with equal facility on roots or stem. However, in the plants examined, the tumors were more numerous on the stems than on the roots of the plants. In this connection, it is interesting to note that on the stems of the plants under observation, the tumors were emerging from each of the axillary buds from which the leaf had fallen off.

EXTERNAL AND HISTOLOGICAL FEATURES

In external appearance the spontaneous tumors are quite similar to the malformations produced by plants infected with the crown gall organism (Plate 90). When growth is formed into the tumors by pinching or cutting back of the main stem of the plant, a number of young shoots arise from the tumors producing the typical "witches' broom" appearance. It has been observed that the shoots produced in this fashion were identical with the mother plant (judged by external characteristics).

The more or less disorganized tissue making up the greater part of the bulk of the tumors is constituted primarily of parenchymatous cells, associated with scattered vascular elements. As the surface of the tumor is approached one finds numerous small, active meristematic areas. There is a rather thick covering of epidermal hairs over the surface of the tumorous regions.

In common with other malformations of a similar nature, the tumors found on the F_1 plants were characterized by an abundant accumulation of starch and tannin. The starch accumulation was chiefly localized in deposits of large oval masses, occupying an entire cell or in some cases two or three adjacent cells. There is also a considerable quantity of starch grains scattered throughout the entire mass of tumorous tissue. The quantity of starch and plastids in tumorous tissue is very much greater than in normal stem tissue. In comparing the histological features of tumorous tissue with normal stem tissue

one is primarily impressed by the lack of regularity of the former tissue. The scattered vascular elements, isolated starch storage cells and large meristematic surface all serve to heighten the impression of irregularity of the tumor tissue.

PHYSIOLOGICAL CHARACTERISTICS

The evidence on some of the more important physiological characteristics of these tumors can be summed up rather briefly:

1. Inoculation experiments have failed to transmit the causal factor or factors to other organisms. Various species of *Nicotiana* were used in attempt to transmit the causal factor from organism to organism (Kostoff, 1930).

2. It was found to be impossible to isolate bacteria or other parasites from the tumors, although several media were used in culturing attempts (Cleveland, from Kostoff, 1930). It should be pointed out that negative results from inoculation experiments and culturing attempts are merely indicative that parasitic organisms were not present but are not positive proof of this condition.

3. The causal factor cannot be transmitted across the graft union. Heteroplastic grafting, using the F_1 in combination with both parent species, utilized as both stock and scion, have failed to transmit the causal factor across the graft union. In combination with other species of *Nicotiana* (*N. Tabacum, N. paniculata*), the F_1 (*N. glauca* × *N. Langsdorffii*) has not been able to transmit the tumor-inducing agent across the graft union. Thus it seems abundantly proved that the tumors cannot be induced in either of the parent species, or in the two other species of *Nicotiana* used in the experiments, by means of grafting.

4. In the plants under observation the tumors developed on the roots during the early seedling stage. Tumors usually begin to appear on the stem during the flowering period, and once tumor formation is initiated, it continues throughout the remainder of the plant's life. In one family of F_1 plants there were five individuals which appeared to have symptoms of tumor on the stem at a very early age. These plants did not develop past the rosette stage and made no attempt to send up a flowering shoot but continued to produce sessile leaves in a crowded fashion, upon a much reduced stem. Root-tip counts of the chromosomes of these plants showed them to be 21 in number, similar to sister plants which were not deformed.

In connection with time-development, it is well to note that as long as the plant is in active growing condition and the terminal meri-

stematic region is active, tumors do not occur on the stem. When the plant has reached a certain physiological age and meristematic activity in the tip region has ceased, this activity is transferred to the lateral axillary buds, and tumor formation begins. The time when the plant begins to flower usually coincides with the time at which terminal meristematic activity ceases and tumor formation is initiated.

5. The tumors are apparently not malignant, at least not in the ordinary sense. Plants having tumors have been kept in good condition for over a year without any particular attention. These plants have never flowered after the initiation of tumor formation but the vegetative growth does not seem to have been impaired.

KARYOLOGICAL OBSERVATIONS

The chromosome number of the cells making up the tumorous areas of the plant can be very easily and quickly determined by the aceto-carmine smear maceration method. The technique used is the same as that employed in making root-tip smears (Whitaker, 1934), except that in making smears of tumor tissue, it is preferable to bring the material to boil in aceto-carmine before smearing. The latter treatment is a distinct aid in obtaining satisfactory maceration of the tissue.

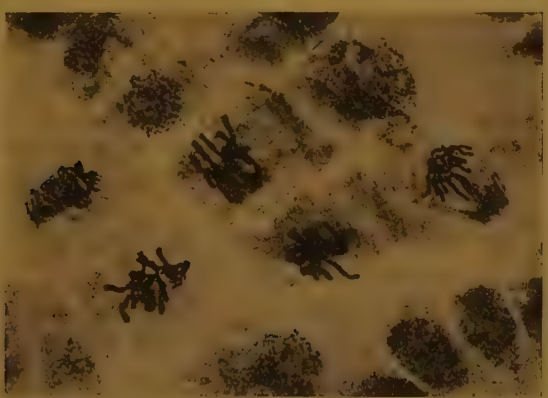

FIGURE 1. Microphotograph of an aceto-carmine smear of tumor tissue (× 2000). The number of cells in various stages of mitosis indicate the active state of reproduction often found among the cells of the meristematic areas.

The chromosome number situation is interesting in view of the findings of Winge (1927) in crown galls produced by *Bacterium tumefaciens* on the sugar beet. Winge has made observations which seem

to indicate that the majority of the tumorous cells are polyploid. He has interpreted this evidence as supporting the hypothesis that tumors result from somatic polyploidy.

The chromosomes in over 40 cells of the tumorous tissue have been counted, and not a single polyploid cell was found. Occasional tetraploid cells have been encountered in other slides but these are undoubtedly very rare.

Mitosis in cells of the tumor tissue seemed to be very regular; there was seldom any pronounced lagging or other irregularity (Text fig. 1). The few irregularities that have been found have not been considered significant.

In examining cells making up the tumor, particular attention was devoted to the nucleus in the hope of detecting karyological abnormalities which might possibly give some clue to the solution of the problem. The percentage of polynucleated cells is almost negligible. Three or four cases of double nucleated cells were recorded, but in only one of these cases could it be positively demonstrated that two nuclei were present in the same cell.

The status of the nucleolus in the tumorous tissue does not vary significantly from that of normal stem tissue. In the normal stem tissue, nuclei with as high as four nucleoli have been observed. Variations within this number have also been found in tumor tissue. The majority of the nuclei in tumor tissue seem to have two nucleoli.

DISCUSSION

In view of these observations, three possible causes of tumor formation have been considered.

1. IS THE CAUSAL FACTOR A VIRUS, BACTERIUM OR OTHER MICROORGANISM? This question is most effectively answered by the grafting experiments. It will be recalled that in these experiments, efforts to transmit the causal factor by grafting were unsuccessful. Many of the known viruses are readily transmissible across the graft union. (Heald, 1926). Further support against the supposition that the causal factor may be a virus is evident from the appearance of the plants which do not exhibit any of the typical known virus symptoms.

The inoculation experiments seem to rule out the possibility of the causal factor being in the nature of a bacterial or fungal parasite. Microscopic observation of both fresh and fixed material points in the same direction; namely, that bacterial and other parasites cannot be regarded as the responsible agents in tumor formation.

2. THE IMMUNOLOGICAL INTERPRETATION. This solution of the cause of spontaneous tumor formation in *Nicotiana* species hybrids has

been advocated by Kostoff (1930). His critical evidence in favor of this view is the "precipitin reaction" occurring between the parent species. The immunological significance of this reaction has been discussed (Chester and Whitaker, 1933). It is sufficient to state that this is not a critical test.

This is a difficult hypothesis either to prove or disprove. The only fact bearing on this question, and it is in no sense critical, is that *N. Langsdorffii* can be used as both stock and scion in graft combinations with *N. glauca*. They appear to be a fairly compatible graft combination. One would think that if species specific substances were diffused by each graft partner, the combination would be an extremely temporary affair. Such is not the case. These combinations are as long-lived as comparable, known compatible combinations and show no ill-effects from their intimate association.

Although the immunological interpretation cannot be eliminated by any of the known facts at the present time, it is a little difficult to visualize a system by which it would work in this instance. It might be possible that if it were an antigen-antibody reaction, the effect would be to limit the hybrid embryo to a few cell divisions, as McCray (1933) has found to be the case in some *Nicotiana* hybrids.

3. A CYTOPLASMIC DISTURBANCE CAUSED BY THE INTRODUCTION OF THE MALE CHROMOSOME COMPLEMENT. In this interpretation of the cause of tumor formation, the assumption is that the disturbance produced by the nine chromosomes of *N. Langsdorffii* in the cytoplasm of *N. glauca* is directly responsible for uncontrolled growth in certain tissues of the plants. This uncontrolled growth is exhibited externally by the tumors. An examination of the evidence indicates that this theory has some merit.

The first essential to have in mind is that the tumors are produced only when *N. glauca* is used as the female parent and *N. Langsdorffii* as the male parent. The reciprocal cross, although difficult to make, has been obtained by McCray (1932). The plants were very vigorous, and there was considerable variation among them. Even though there was a marked amount of variation among the F_1 individuals there was no reason for thinking that this was not a legitimate F_1 between the two species. From this work it seems to be clear that a reciprocal F_1 has been produced (*N. Langsdorffii* used as the female), and tumors were not present (McCray, private correspondence).

Theoretically if a back-cross to either species could be obtained, it should yield critical data on the validity of the proposed explanation. Back-crosses to the *N. Langsdorffii* parent have been made by employ-

ing the F_1 as the female parent (Kostoff, 1930). The progeny of such a mating should all possess tumors in a greater or less degree, since in such a system of matings no *N. Langsdorffii* cytoplasm has been introduced. It is not clear from Kostoff's description of the progeny of this mating whether all the plants had some indication of the disturbance. Apparently the majority of them had fasciations, which appear to be a milder expression of the disturbance than the spontaneous tumors. A smaller number of these plants had tumors, reported to be as large and as numerous as the tumors formed on the F_1.

The time of development does not offer serious difficulties in the path of the above explanation. The tumors are present in the very early seedling stage, at least on the roots. They were first visible on the stem about the time of flowering. If the effect is that of chromosomes upon cytoplasm, one would rather expect that it would exert a continuous influence from the earliest divisions following fertilization on through the life of the individual. The first indication of spontaneous tumors occurs in the roots where they are found shortly after germination. This seems to indicate that there is a continuous expression of the disturbance from immediately after germination on through the remainder of the life of the individual.

We have examined the evidence bearing on the explanation of tumor formation in the F_1 of *Nicotiana glauca* × *N. Langsdorffii*. How does this fit in with other cases of tumor occurrence reported in hybrid Nicotianas?

The cases in which tumors have been reported are listed in Table I.

TABLE I

	Chromosome No. (n)		Chromosome No. (n)	Investigator
N. quadrivalvis	24	× *N. Sanderae*	9	Holmes (private correspondence)
N. rustica	24	× *N. Sanderae*	9	Kostoff
N. Tabacum wigandioides	24	× *N. Sanderae*	9	Kostoff
N. paniculata	12	× *N. Sanderae*[1]	9	Kostoff
N. paniculata	12	× *N. Langsdorffii*	9	Kostoff
N. rustica	24	× *N. Langsdorffii*	9	Kostoff
N. rustica	24	× *N. alata*	9	Kostoff
N. Tabacum sanguinea	24	× *N. alata*	9	Kostoff

[1] *N. paniculata* × *N. Sanderae* must be considered as a doubtful case for the reason that the tumors did not appear on the stems, and it was questionable whether there were tumors present similar in nature to the cases cited above. Moreover, Christoff (1928) has produced this same F_1 combination, and in describing the plants, he makes no mention of the occurrence of tumors.

It is evident, from an inspection of Table I, that, in the combinations producing tumors in the F_1, the alata-group (*Nicotiana alata, N. Sanderae,* and *N. Langsdorffii*) having nine chromosomes is always involved as the male parent. There is one possible exception that should be mentioned. Kostoff (1930) records the F_1 hybrid of *N. rustica humilis* × *N. Tabacum sanguinea* as producing malformations, causing it to be placed with the tumor-producing hybrids of *Nicotiana.* It is distinctly questionable whether it belongs in this category. Tumors were not present on the stem or if present were not noticeable. A slight fasciation was produced which may or may not have been similar to the fasciations produced by the truly tumorous F_1 hybrids. The argument advanced above may well serve to account for tumor formation until more information on the progeny of this cross is available.

The explanation of tumor formation that has been offered, in which the cause has been assumed to be the disturbance originating from the introduction of *N. Langsdorffii* chromosomes into *N. glauca* cytoplasm, can be very easily extended to include the alata-group. The evidence presented in Table I signifies that the same forces are at work in this group of F_1 species hybrids as were found in the F_1 progeny of *N. glauca* × *N. Langsdorffii.*

In cases where reciprocal crosses have been obtained (alata-group used as the female parent) tumors have not been recorded as being present on any of the plants. For the reason that it is somewhat easier to secure crosses in which the species with the higher chromosome number is used as the female parent, most of the reciprocal crosses have not been successful, but where it has been possible to secure fertile crosses and hybrids brought to maturity, tumors were not reported in the description of the F_1 plants. The two cases where reciprocals have been obtained are: *Nicotiana Langsdorffii* × *N. Tabacum* and *N. Sanderae* × *N. Bigelovii* (from East, 1928). The fact that tumors were not recorded by the observers cannot be taken as absolute proof that they were not present, but there is the greatest likelihood that if tumors were present they would have been at least mentioned. It, therefore, seems safe to assume that these reciprocal F_1 hybrids were devoid of tumors.

One major criticism that can be made of the cytoplasmic disturbance theory, when applied to the three species belonging to the alata-group, is that the reactions of all three species are not the same when mated to a common species as far as the production of tumors is concerned. As an example of this point, take the cases where *Nicotiana glauca*

has been used as a female with *N. alata*, *N. Sanderae*, and *N. Langsdorffii*. In the first two cases the F_1 does not produce tumors. In the last case the F_1 produces tumors in great abundance. If we were dealing with a comparatively simple phenomenon, it seems reasonable to expect that all of the alata-group, when mated to a common species (*N. glauca*), would have similar reactions. That such is not the case has been pointed out above.

The evidence is fairly conclusive that when the 9-chromosome group of *Nicotiana* is introduced by the pollen parent into the cytoplasm of certain other *Nicotiana* species, there occurs a loss of control of growth by the organism in the meristematic areas. As a result of uncontrolled growth, tumors appear first on the roots and later on the axillary buds of the stem.

SUMMARY

1. Spontaneous tumors occurring on F_1 species hybrids between *Nicotiana glauca* and *N. Langsdorffii* have been studied from several different viewpoints in an attempt to discover the underlying causes for their occurrence.

2. All the available evidence indicates that the tumors are the direct result of a cytoplasmic disturbance. The disturbance is occasioned by the introduction of the chromosome complement of *N. Langsdorffii* (used as the pollen parent) into the cytoplasm of *N. glauca* (used as the seed parent).

3. The reported cases of spontaneous tumors in the F_1 of species hybrids of *Nicotiana* have been analyzed. All of them seem to be due to a cytoplasmic disturbance caused by the introduction of the chromosomes of the alata-group (*N. alata*, *N. Sanderae*, and *N. Langsdorffii*) used as the male parent into the cytoplasm of certain other Nicotianas (*N. glauca*, *N. paniculata*, etc.) used as the female parent.

I am very grateful to Professor E. M. East of Harvard University for certain suggestions regarding interpretation and for critical reading of the manuscript.

Tumors on Nicotiana Hybrids

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EXPLANATION OF PLATE 90

Main branch of an F_1 hybrid between *Nicotiana glauca* and *N. Langsdorffii* about one year old showing the frequent occurrence of spontaneous tumors.

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[1]A recent publication by Kostoff (Tumor problem in the light of researches on plant tumors and galls and its relationship to the problem of mutation. Protoplasma, 20:440-456, 1933) came to hand after the completion of this manuscript. It is simply a review of his previous work, with an attempt to homologize spontaneous plant tumors with malignant tumors of animals (cancers). No new data have been presented. The interpretation is the same as in the previous work.

NOTES

Blister Rust of Pinus longifolia Roxb. — Blister rust diseases of pines rank among the most important of tree diseases. They are known on both hard and soft pines throughout the northern hemisphere. Most are caused by heteroecious rust fungi and with few exceptions the causal organisms are incapable of passing directly from pine to pine. Several have received considerable study, but comparatively little is known about the majority of them. The most exhaustive investigations have been made on the highly destructive blister rust of 5-needled pines caused by *Cronartium ribicola* Kleb., and for its control eradication of *Ribes* has been thoroughly demonstrated as an effective measure. There now comes from the pen of Dr. K. Bagchee, Mycologist of the Forest Research Institute at Dehra Dun, India, the second part of an account[1] of comprehensive researches carried out by him on a hitherto little-known blister rust of "chir," a 3-needled pine (*Pinus longifolia* Roxb.), which is destructively prevalent in some of the forests of northern India, particularly in the pine forests of the Kumaon and Garwhal Himalayas. Dr. Bagchee's paper is reviewed below and to the review is added a brief comment on the nomenclature applied to the causal fungus. The quotations cited are from that paper unless otherwise indicated.

Pinus longifolia is regarded as "one of the most important forest trees in the Himalaya." Its wood is employed for ordinary furniture, general carpentry, heavy timber of all sorts, railway ties, resin production, and to some extent as fuel. "This pine is also of considerable importance as a park, garden, avenue and ornamental tree."

Barclay appears to have been the first to make mention of the fungus on chir that causes blister rust. In the opening paragraph of his description of *Aecidium complanatum* nov. sp. on *Pinus longifolia* Roxb. Barclay commented, "I have only once seen it on the stem (var. *corticola*) and my further remarks refer only to the variety on the needles." (BARCLAY, A. A descriptive list of the Uredineae occurring in the neighborhood of Simla [Western Himalayas]. Pt. III. Jour. Asiatic Soc. Bengal, **59**:101. 1890.) Reports of death of young chir trees, causes undetermined, began to issue in 1891; but it was not

[1] BAGCHEE, K. Investigations on the infestation of Peridermium himalayense Bagchee on Pinus longifolia. Part II. Cronartium himalayense, n. sp., on Swertia spp. Distribution, morphology of the parasite, pathological study of the infection, biological relationship with the pine rust, and control. (Indian Forest Records, **18**:1-66, front., pl. 1-17. 1933.)

until 1915 that blister rust "was definitely recorded as apparently doing much damage." According to Dr. Bagchee the causal fungus is seemingly native to the inner valleys of the Himalayas, and he believes that it later spread to the outer ranges. Earlier accounts referred to above, indicated sporadic outbreaks "in some of the chir forests of Kumaon," but now there is "a typical widespread epidemic involving heavy loss in the young pine stands in the Kumaon and Garwhal Himalayas."

The attack of this disease, both in plantations and natural forests, is on young trees (seedlings and saplings) up to 20 years of age. "The heaviest infection occurs on young plants 2 to 3 feet high" (Part I.) "Trees beyond 20 years of age appear safe from infection." It is of interest to note that even very young seedlings are susceptible; successful inoculations were made on seedlings between one and two years of age. "Such plants died within one year after inoculation and histological examinations showed the presence of numerous hyphae and haustoria in the cambium and cortical cells." Indeed, death of these plants ensued before there was time for the fungus to form aecia. So far as could be determined "healthy and vigorous regeneration is as much open to such danger as plantation crops," and the disease is not one which is more particularly restricted, as some foresters have maintained, to weak or suppressed plants. The amount of damage suffered in the pine forests of the Kumaon and Garwhal Himalayas has not been statistically estimated, but is considered to be very great. As extreme instances Dr. Bagchee informs us that in one locality examined carefully by him the disease had killed 60 percent of the saplings and of the remaining 40 percent scarcely any were free from infection; in the Almora Forest Division the mortality of young seedlings left wide gaps in the stand, and attempts to fill these by occasional sowings had failed because of the wholesale destruction of seedlings as rapidly as they appeared. "The increase in the rate of mortality as a result of the attack of this bark-inhabiting fungus pest, has threatened to wipe out the pine in the plantations close to Almora." (Part I.)

The lesions caused are stem cankers and are accompanied by little or no swelling. They closely resemble the lesions caused by *Cronartium Comptoniae* on such a pine as *P. Banksiana*. "Under the attack of the parasite the plant dries up and finally dies from the girdling of the stem" (Part I.). The youngest hosts are killed rapidly, but on older ones, according to their age, the cankers persist for from two to many years, spreading from year to year until girdling is completed.

One of the objectives projected by Dr. Bagchee was a determination of the life history of the causal organism. After long, discriminating search a *Cronartium* was discovered on three species of *Swertia* (a genus of the Gentianaceae), annual herbs widely distributed on the forest floors in the affected regions, namely, *S. angustifolia, S. alata* and *S. cordata*. Then followed a series of sound, painstaking experiments, often impeded because of unforeseen technical difficulties, that culminated in ample, positive demonstration of the fact that the blister rust fungus alternates between *Pinus longifolia* and any one of the three species of *Swertia* named. We now have a picture of the life cycle of the blister rust fungus, adequate in its general outlines, and complete in many of its details. The spermogonia emerge in the pine during October or November, not sooner than the year following infection, the incubation period being variably protracted. "The aecidial stage may appear in the following spring or a year later on the same parts of the plant where pycniospores were detected during the previous autumn." A copious crop of aeciospores is produced and they may be wind-borne for very long distances. Infection of *Swertia* takes place immediately, and in from 9 to 15 days after inoculation uredospores are evident. "As in *Cronartium ribicola*, so with this fungus, there is a successive series of uredospore productions which are again followed by a similar series of teleutospore crops. In 1927 when this fungus was first noticed in Kaligadh seven series of uredospore crops were counted. This was succeeded by a mixed crop of both uredo and teleutospores till the end of October. * * * As compared with the uredosori, the teleutosori are produced in relatively greater abundance with each succeeding generation. Up to six distinct waves of teleutospore crops were counted in 1927, and about three crops in 1928." The teliospores germinate promptly *in situ* and the basidiospores are disseminated by air currents, just as is true of the dissemination of aeciospores and uredospores. Exact data on the effective ranges of uredospores and basidiospores have not yet been obtained, but the author arrives at the tentative conclusion that "600 yards for uredospores and 200 yards for sporidia may be taken as the preliminary working distance for control measures." Since the *Swertia* plants die in the fall and neither uredospores nor aeciospores so far as could be determined overwinter in a viable condition the fungus is apparently carried over solely by the perennial mycelium in the cankers on the pines.

Considerable space in the paper under review is given over to a discussion of possible control measures. The author dismisses all

except that of eradication of *Swertia* as being impracticable or of relatively little value. Some observational evidence is adduced in support of these opinions. "Eradication of the alternate host is recommended as the only suitable measure to deal with this disease effectively. * * * A scheme has been suggested for the eradication of *Swertia* spp. for three years in succession and thereafter in alternate years for six eradication years in Periodic Block I areas. The best time for eradication operations is soon after the rains till early autumn, before the *Swertia* seeds mature and are dispersed."

Dr. Bagchee fully describes the causal fungus and chooses to call it *Cronartium himalayense,* sp. nov. "in uniformity with the aecidial stage" which he had previously described under the name *Peridermium himalayense,* a name which he considers particularly appropriate because of the Himalayan native habitat. He reduces to synonomy *Uredo Opheliae* Sydow, a name based on the uredo phase and published with description by H. and P. Sydow in 1903. *Ophelia* is a subgenus of *Swertia.* Based on the claim of greater appropriateness the choice of *C. himalayense* is, of course, not permissible according to international rules of nomenclature. A more valid claim could be advanced because the teliospores are described here for the first time. Many competent mycological taxonomists, however, in their interpretation of the rules, maintain that names based on the uredo phase given prior to names based on the telial phase retain priority. This view is reasonably based. In my judgment, therefore, the correct name of this fungus is **Cronartium Opheliae** (Sydow), n. comb., with synonyms *Aecidium complanatum* Barclay var. *corticola* Barclay (without description), *Uredo Opheliae* Sydow, *Peridermium himalayense* Bagchee and *Cronartium himalayense* Bagchee.—J. H. Faull.

Wehmeyer's "The Genus Diaporthe Nitschke and its Segregates"—The taxonomic literature of mycology has been piling up apace during the long period of years from Persoon and Fries onward, a constantly mounting mass of descriptions of myriad fungus species. Much of it never satisfactory, the difficulty of using it increases as the unceasing cumulating process continues. This is not a necessary attribute of volume because if the unit constituents are properly depicted and properly named, a directory of Linnean quality to point the way clearly throughout can be formulated. The two outstanding defects are inadequacy of many of the descriptions and interspersion of undetected aliases. The former is referable to scanty material or lack of knowledge of diagnostic characters in phases of life cycles often not

yet determined, and sometimes simply to hurry, carelessness or incompetence. Unwarranted multiplication of names is the result of another set of causes. In the appraising of supposedly new species taxonomists have without justification created new names, some because they have overstressed host affiliations, others because they have been unduly influenced by erroneous conceptions of geographical restriction, or have lacked necessary library facilities, or more often still have not been familiar with the type materials of pertinent groups. What a boon to the subject it would be if types or portions of types were stored in designated emporiums, emporiums in one or another of which the deposition of type material would be a requirement to the establishment of nomenclatorial priority, not less so than the writing of Latin descriptions.

That mycological taxonomic literature is in need of subjection to a 'purification process," especially with respect to an improvement of descriptions and a weeding out of synonyms masquerading as principals, is obvious. It is true that this has already been done for a comparatively few genera or groups of allied genera, but for the main part these are small or geographically limited in their distribution. The most ambitious accomplishment is represented by Sydow's monumental Monographia Uredinearum. But the great mass still remains untouched. It is with joy, therefore, that we hail the appearance of every contribution to the purifying process. A work of this kind has just come from the hand of its author; I refer to a monograph on "The Genus Diaporthe Nitschke and its Segregates" by Dr. Lewis E. Wehmeyer of the University of Michigan.

This work, published as a book of 347 pages and 18 full-page plates, is issued (1933) from the University of Michigan Press, Ann Arbor, as Volume IX of the Scientific Series, University of Michigan Studies. The volume is large octavo size, beautifully printed on good paper and well bound. The University of Michigan Press is to be congratulated on the excellence of the workmanship throughout, and the editor on the choice of format and care in proofing.

The genus *Diaporthe* is a large, but compact caulicolous group of fungi, world-wide in distribution. Most species occur on woody stems. A few are known to be parasitic and there are indications that several others may be weakly so. More than 650 species names are in existence; they are accompanied by descriptions, poor, good and all grades between; some are based on morphological characters, others virtually on host relationships. They owe their being to about 110 authors. A number of the types cannot be located, and it is safe to say that the

rest are scattered far and wide, some treasured in readily accessible herbaria, private or institutional, others in out-of-the-way places and variously housed. As a topic for monographic treatment *Diaporthe* is not more interesting than many others, nor is it less so. None is surely in much greater need of revision, and few present a more formidable undertaking.

Dr. Wehmeyer's preparations for the undertaking were laid with care and thoroughness. He devoted himself during a long period of years to foundation studies on the morphology, life histories and host relationships of representative species of *Diaporthe* and extended some of his studies to similar genera. Portions of the results were published from time to time, a series of valuable papers. They comprised such papers as "The imperfect stage of some Pyrenomycetes obtained in culture" (1923), "Cultural life-histories of certain species of Eutypella, Diatrypella and Cryptovalsa" (1925), "A biologic and phylogenetic study of the stromatic Sphaeriales" (1925), "Further cultural life-histories of the stromatic Sphaeriales" (1926), "Cultural life-histories of Diaporthe" (4 papers, 1926-1929), "Studies on the rôle of the host in the genus Diaporthe" (1930). It is especially worthy of note that he gave close attention to the topic of host restrictions and that he worked out the life histories of 26 species of *Diaporthe* or its segregates. His preparation, therefore, resulted not only in important extensions to our knowledge of these fungi, but also enabled him to become widely acquainted with the materials of his subject and to orient himself on sound principles to be applied in making a taxonomic revision.

The introductory chapter of Dr. Wehmeyer's book is well written, comprehensive and at the same time concise. He discusses his treatment of the genus, explains the morphology and development characteristic of the genus, defines descriptive terms employed, points out the peculiarities of the segregates, gives a picture of the distribution and closes with a key to the genera. Space does not permit reference to the many interesting points dealt with in this introduction. Certain features, however, should be noted. Thus in his treatment, "species are separated on purely morphological grounds," whereas "the general practice in the past has been to describe as a new species every occurrence on a new host genus, regardless of the similarity of the morphological characters." "Under each morphological species which appears on a number of hosts a description of the occurrence and a synonymy of each of the host forms are given." The conidial stage of *Diaporthe* proper proves to be *Phomopsis* (as limited by Diedicke) or Phomopsis-

like, but for the segregates other forms are represented. With regard to the diagnostic value of stromatic and conidial characters he re-affirms earlier conclusions, namely, (1) "stromatic characters are likely to be more plastic and variable than conidial characters; on the other hand, certain tendencies or differences in range of variation of stromatic characters may be quite constant and characteristic, and when correlated with the host may indicate definitely separated species"; (2) conidial size and shape for a particular species appear to be quite constant regardless of substratum; (3) "specific separations on slight morphological differences in the perithecial stage often become more pronounced when the imperfect stage is known"; (4) "morphological differences in both the perithecial and conidial stages are often definitely correlated with the host, indicating that closely related species with slight morphological differences are often definitely limited as to their host species under natural conditions" (1930). "All citations of hosts, distribution, and exsiccati * * * are based upon material actually examined by the writer."

The introduction is followed by chapters with the following headings—*Diaporthe* Nit. emend. (pp. 14-188), *Cryptodiaporthe* Petrak emend. (pp. 189-215), *Diaporthella* Petrak (pp. 216-218), *Apioporthe* Höhn. emend. (pp. 219-227), *Diaporthopsis* Fabre (pp. 228-234), Doubtful Species (pp. 235-241), Excluded Species (pp. 242-271), Species Not Seen (pp. 272-334); and the work ends with an excellent index of genera and species; it would have helped were the hosts also listed or a separate host index prepared. The chapters on the various genera are prefaced by carefully constructed keys. The results of the purifying process with respect to the number of species accepted and the disposition of them is startling. Sufficient data were not available to enable him to be certain of 18 of the species; they are placed in a chapter by themselves and described as well as possible. Eighty-seven are excluded altogether; these, too, constitute the subject matter of a chapter; with reasons assigned they are properly referred wherever possible. The most startling feature is the drastic reduction of names to synonymy; in all, upwards of 350 species names are so reduced. As striking instances I note 118 synonyms for *Diaporthe eres,* 34 for *D. Arctii,* 22 for *D. pardalota* and 21 for *D. medusaea.* The count of accepted species shows 71 for *Diaporthe* (6 of which are new), 19 for *Cryptodiaporthe,* 3 for *Diaporthella,* 8 for *Apioporthe* (1 new), and 6 for *Diaporthopsis* (1 new). The reviewer has not taken time to check on author's adherence to the international nomenclatorial rules. One important deviation was noted in the case of *D. medusaea;* two older

names are rejected, one (*D. rudis*) because of "absence of type material," the other (*D. faginea*) because it "gives the wrong impression of this collective species." The latter does not seem a sufficient excuse for violation of the rules. The closing chapter deals with species not seen, 148 all told. Persistent and time-consuming as have been Dr. Wehmeyer's efforts he has not found it possible to see material of any of those species. Fifty-four of them are said to be reported from South America; presumably most of them are in Spegazzini's herbarium. Forty-one are from Italy; presumably most of them are in Saccardo's herbarium. The hope is expressed that the author will complete his undertaking, not resting until existing types of the "species not seen" are seen and made to pass through the purifying fire of his critical study.

In spite of its lack of completeness Dr. Wehmeyer has contributed to mycology a work of outstanding merit. There will not be universal acceptance of every one of his conclusions, partly because of honest differences of opinion as to just where lines should be drawn between species, and partly because added knowledge of life histories will demand revisions. But all mycologists will rejoice in the fact that the subject matter has been assembled, coordinated and presented in clear perspective. It will long remain as the standard work on *Diaporthe* and its segregates.—J. H. Faull.